

MAY 1994



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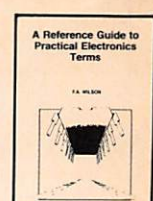
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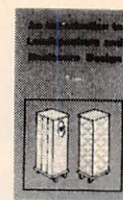
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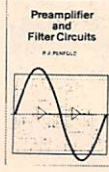
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CONSTRUCTION ARTICLES

BUILD THIS DISTINCTIVE RING SWITCH	Bruce Layne	33
<i>Route your telephone calls to the appropriate person or device</i>		
A TIME-DELAYED MODEL-ROCKET LAUNCH CONTROL	Dan Becker	41
<i>Add a touch of class and safety to your hobby with this deluxe controller</i>		
BUILD A REMOTE-CONTROL RELAY STATION	John Yacono	69
<i>Extend the range and the usefulness of your remote controls</i>		

FEATURE ARTICLES

DOCUMENTATION	Jack Cunkelman	37
<i>Save yourself and others from headaches by properly documenting your projects and designs</i>		
LIGHTNING AND THE RADIO LISTENING POST	Karl T. Thurber	44
<i>Protect your gear and yourself from the fury of nature</i>		
BEYOND OHM'S LAW	Paul Coxwell	66
<i>Use these methods to analyze complex circuits</i>		
ALL ABOUT TRANSISTORS: FET's	Robert A. Young	71
<i>Learn about field-effect transistors and how they work</i>		

PRODUCT REVIEWS

GIZMO		51
<i>Winter Consumer Electronics Show round-up, and more</i>		
HANDS-ON REPORT		22
<i>Media Vision Memphis multimedia upgrade kit</i>		
PRODUCT TEST REPORT	Len Feldman	24
<i>Mitsubishi HS-U57 videocassette recorder</i>		

COLUMNS

MULTIMEDIA WATCH	Marc Spiwak	4
<i>"Terminating" your PC</i>		
THINK TANK	John Yacono	26
<i>Addresses and answers</i>		
ANTIQUE RADIO	Marc Ellis	75
<i>The NBS crystal set continued</i>		
COMPUTER BITS	Jeff Holtzman	77
<i>A shell of a dashboard</i>		
CIRCUIT CIRCUS	Charles D. Rakes	79
<i>Some assorted circuits</i>		
DX LISTENING	Don Jensen	84
<i>Shortwave-broadcast funding</i>		
HAM RADIO	Joseph J. Carr	86
<i>Receiver performance today</i>		
SCANNER SCENE	Marc Saxon	88
<i>Scanners under fire</i>		

DEPARTMENTS

EDITORIAL	Carl Laron	2
LETTERS		3
ELECTRONICS LIBRARY		8
NEW PRODUCTS		14
ELECTRONICS MARKET PLACE		81
POPULAR ELECTRONICS MARKET CENTER		97
ADVERTISER'S INDEX		128
FREE INFORMATION CARD		129

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FUN AND GAMES

Fortunes are won and lost in Las Vegas all the time, but the stakes are never higher than when the Consumer Electronics Show moves into town each winter. In that respect, the 1994 show wasn't any different, with manufacturers looking for ways to liven up the lackluster sales of the recent past, hoping to find that elusive "must-have" product or device.

Among the clear stars (no pun intended) of the show were digital satellite TV (DSS). Following the successful launch of the Hughes DBS1 satellite this past December, the Thompson/RCA booth was jammed for much of the show. That was not surprising; considering the superior audio and video quality promised, the diversity of programming (as many as 150 channels will be available from two independent suppliers), and user convenience (a tiny 18-inch dish and sophisticated programming guides), DSS could provide cable-TV operators with the stiffest challenge they have ever faced.

Another significant development was the continuing move of multimedia into the mainstream of consumer electronics. Judging from CES, the CD-ROM is rapidly becoming a consumer appliance. Many hardware and software vendors were in attendance, some for the first time. Even chip-maker Intel was present, with its giant "Disney-like" display. What's more, stand-alone multimedia platforms such as the 3DO system and Philips CD-i competed for attention with newcomers from Atari, Commodore, JVC, and others.

There was, of course, much more at the show. For the full story, turn to our Gizmo section, which begins on page 51.

Carl Laron
Editor

ADDRESS CHANGE

Thank you for mentioning Allied Electronics in the article "Where to Find Electronic Parts" (*Popular Electronics*, November 1993). We would like to advise you and your readers of our change of address to: 7410 Pebble, Fort Worth, TX 76118-6997.

Again, we appreciate your comments. Look for our newest release of the "Engineering Manual and Purchasing Guide" in May.

RUTHETTE RAINES
Allied Electronics, Inc.
Fort Worth, TX

MORE ON METRIC CONVERSION

I am writing to endorse the comments of your correspondent from Tulsa regarding the use of the metric system (*Popular Electronics, Letters*, January 1994).

Here in England, there has been a gradual change to metric units over the last 20 years or so, and government regulations have repeatedly told various businesses what units must be used for various purposes. Packaged foods are now sold in weights of 500 grams, one kilogram, and so on, with liquids measured by the liter, centiliter, or milliliter. Many packets and bottles do not even show an English equivalent. Postage rates are now based on 10-gram increments, and in the last couple of years all our gasoline pumps have been changed to liters.

About the only officially controlled measurement that has yet to be changed is the use of miles for road distances, although there has been considerable talk about switching to kilometers. We are already seeing warning signs (such as for the end of a lane or a concealed entrance) with distances in meters instead of yards. Even our weather forecasts require the use of a conversion table now, as few announcers seem to give temperatures in anything but centigrade. (I believe that the centigrade scale is not, strictly speaking, part of the metric system, anyway.)

Unfortunately, it appears that

the people in charge of broadcasting, publishing, education, and so on, support the change. I am informed that British schools do not even teach English units any more! A visiting American might be given the impression that we all welcome the change. In fact, I do not know one person who is in favor of the switch to metric, and I can only guess at the expense that has been incurred by businesses to alter packet sizes, change measuring devices, and so on.

The usual "explanation" by official departments is that Britain is being more closely integrated with Europe, and the rest of continental Europe uses metric exclusively. So what? Europeans speak different languages, have different customs, and even use a comma in place of a decimal point when writing numbers. Imagine the ensuing chaos if that crazy idea was introduced! All that aside, the majority of British people have no desire to be integrated with Europe, anyway. I'm sure that the majority of Americans also have no wish to switch to unfamiliar units just because most of the world uses them.

Sure, I'll use metric units when they are appropriate. We all measure radio wavelengths in meters, for example. The fact remains that for normal, everyday measurement American and British people are used to using English units and will continue to do so.

It is a pleasure to visit the United States and see English units in use once again. Don't be pressured into an unwelcome, confusing, and expensive change to satisfy the rest of the world.

P.C.
Sutton-on-Sea, England

HAVES & NEEDS

After getting a couple of great deals on surplus equipment, I

have come back to earth and need to know what to do with it. I would appreciate any information (operation, service, schematics) on either the Philips Type PM3500/Q 16-channel logic analyzer (circa 1980) or the Tektronix Type 611 storage display unit MOD162C (circa 1970). I would be more than happy to cover any reasonable expenses.

Thanks for your help, *Popular Electronics*. Careful with those computer articles: I had to drop my subscription for a while there, but I'm happy we're back together.

MICHAEL C. CORDER
P. O. Box 328754
Columbus, OH 43232

I have a Sencore PS163 oscilloscope that is no longer

made. The trace is to one side of the screen. I need a schematic diagram or information on which potentiometer controls the adjustment for that problem. Thank you in advance for your help with this.

KENNETH YURKOVITCH
23 Roosevelt Ave.
Selden, NY 11784

I've seen other readers get lucky, and now I'm hoping it's my turn. I am looking for an owner's manual as well as a service manual for a Setton Stereophonic Receiver Model RS440. I will gladly pay for copying or postage costs.

Thank you.
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MULTIMEDIA WATCH

By Marc Spiwak

My PC gets Terminated

The multimedia industry is at full boil right now, and new CD-ROM titles are turning up faster than ever. Today, a multimedia-PC owner can buy a CD-ROM to supplement almost any hobby interest. Buying a CD-ROM is like buying a book—except that it's a huge book with sound, video, and search capabilities thrown in. Many CD-ROM's contain more information than any one owner will

ing for before they buy a computer. A home computer is presently the only one can use to unlock the vast amounts of information available on CD-ROM.

The PC's ability to display real-time video, and the CD-ROM's ability to hold vast amounts of it—not to mention sound—are surely significant factors in the recent surge in multimedia. Video, or even simple animation, if properly used, can greatly enhance the effect of almost anything. Seeing how an animal walks, how an engine works, or how a certain task is performed can be a lot more informative than a simple photo or diagram.

Today there are many different desktop-video formats. Many require nothing more than a fast computer to view them, and some require special hardware for playback. In comparison, however, very few hardware/software combinations can be used to record video with a PC, especially at an affordable price. Media Vision's *Pro MovieStudio* attempts to fill that void.

THE PRO MOVIESTUDIO

I've been having a lot of fun lately with my *Pro MovieStudio*. An add-in board for PC compatibles, it lets me input, digitize, and compress video signals. The board can handle composite and S-video, in either NTSC, PAL, or SECAM format. Audio is not handled by the board, so a separate sound card is required for making

"talkies" (but anyone playing with a *Pro MovieStudio* most likely has a sound card already). Now, instead of just having my computer (actually Arnold) say "I'll be

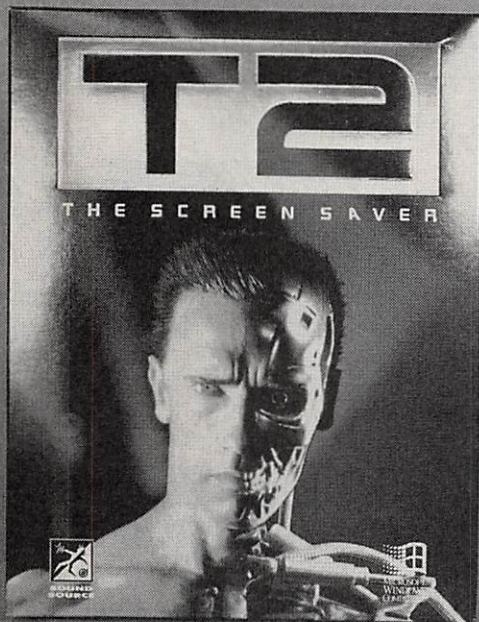


If you are an avid videographer or movie buff and own a PC, the Pro MovieStudio is definitely worth taking a look at. It's probably right up your alley.

back," I can have the video clip of Arnold pop up on my screen as well.

The *Pro MovieStudio* includes the board, DOS and Windows software to drive it, a manual, Microsoft's Video for Windows with a complete instruction manual, and Macromedia's Authorware Star with its complete manual. A CD-ROM full of sample video clips is also included, although you don't need the *Pro MovieStudio* to play the clips—only to record new ones.

Video for Windows is the software that lets me capture, edit, and play back my mini movies. VidCap, which is part of the VfW package, can capture single frames, multiple frames, and video sequences, and store them on a hard drive. Video clips are saved to disk in the Audio/Video Interleaved (AVI) file format, which yields



The Terminator is now here to protect monitors from screen burn-in. If you need his services, contact Sound Source Unlimited, Inc.

ever see, but at least the discs don't waste much space. CD-ROM's could actually turn out to be just the thing that everybody's wait-

fully editable video clips in which the audio and video remain synchronized. VFW also includes VidEdit (which allows simple cut-and-paste editing of AVI files) and Media Player (which is used to play back AVI files). A DOS-based utility is also included that allows capture and playback of AVI files in DOS, although the Windows software is a lot easier to use and is far more powerful. One Macintosh disk is also included. That software lets you convert AVI files to QuickTime, the Macintosh video standard, which has also been ported over to the PC. (It does get confusing, doesn't it?) Authorware Star is an object-oriented software-authoring tool, which has now been upgraded to handle digital movies including VFW material.

REQUIREMENTS

The Pro MovieStudio must be installed in an empty 16-bit expansion slot in a 386SX or higher that has at least 2 MEG of RAM (4 recommended) and a color VGA monitor. The card requires one IRQ, one I/O-port address, and a memory range. Software sets those for you automatically. DOS 5.0 or higher and Windows 3.1 are also required.

At least 8 MEG of hard-disk space is required just for all the bundled software, and you'll need a lot more than that for AVI-file storage. AVI files gobble up meg's and meg's of hard-disk space. Some time after experimenting with the Pro MovieStudio, I was cleaning out my hard drive and found about 50 megabytes of "cutting-room-floor stuff"—bits and pieces of video that I meant to discard but forgot about. That 50 meg didn't include the clips I wanted to keep! Even if you don't intend to save

video clips, a lot of free disk space is required just to work with AVI files.

Ideally, AVI files can be recorded at 30 frames per second maximum, with 16-bit audio sampled at 44.1 kHz—but that's only on an ideal (fast) PC. The slower the system, the less frames per second it will be able to record. My DX2/50 had no trouble with 30 frames per second, at least in small windows. Video images can be captured in sizes ranging from 80 × 60 to 640 × 480, but 30 frames per second can only be had in smaller windows. A 240 × 180 image is a nice compromise between size and speed, but note that that is true only on a fast machine.

As hardware installations go, installing the Pro MovieStudio was a breeze. The card pops in an empty slot and, as the software handles its configuration, the card has no jumpers to set. In fact, the software does a pretty good job of configuring the card. The only problem I had was that the installation excludes a section of upper memory for Pro Movie-use only, and

SOURCES

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that RAM was being used for something else loaded high on my machine. As a result, the other piece of software loaded low, leaving too little conventional memory to run some of my other applications. Such is life—rather, such is a PC! Anyway, with a little bit of upper-memory management, things were back to normal, and the MovieStudio worked right away.

The Pro MovieStudio has a list price of \$449, but I've seen it for sale mail order for just over \$300. Is it worth it? I think so. If you've got a fast multimedia PC, and you're looking for more ways to have fun with it, then the Pro MovieStudio's price is justified, especially if it helps launch a career in film-making.

Fun and games aside, the Pro MovieStudio is an

inexpensive way for anyone with a video camera to get any image into their computer. I've got the Pro MovieStudio hooked up to my VCR, so I can capture bits of any TV program or any video tape. Granted the final image quality is limited by the resolution of the original video format. Even S-video is grainy when compared to a color photo that's been scanned at 1200 dpi, but S-video, or even NTSC quality is sufficient for many non-professional applications, such as making your own catalogs and newsletters, where picture sharpness is not all that important.

NEW STUFF

DeLorme Mapping has recently introduced Version 2.0 of the fantastic *Street Atlas USA* CD-ROM, which includes every street in the

United States. The program is fantastic in that it lets you zoom into any city or town and find any street. The new release includes tens of thousands of new streets built since the first disc was published. In the process, the Street Atlas database has been increased from 480 MB to 640 MB, yet it still fits on one disc. While the program has always run in Windows, only now have built-in printing capabilities been added. Before you'd have to cut maps to the clipboard and process them with some other software. Now you can print clear, sharp maps right from Street Atlas. Priced at \$169 for new customers, and \$49 for upgrade customers, this disc is a winner.

LucasArts' first CD-only title, *Rebel Assault*, is here. The disc is packed with great action, 3D graphics, voice-overs, and a score performed by the London Symphony Orchestra. The CD-ROM is good not only for graphics, but for hard drives as well. The entire game can be played from the CD-ROM, which is a far cry from older games like *X-Wing* that needed 10 meg's of your hard drive. The player assumes the role of Rookie One, a Rebel fighter pilot. Fifteen different levels of game play take Rookie One all the way from training in Beggar's Canyon to the trench run on the Death Star. For \$79.95, this is as close to a galaxy far, far away as you can get!

Children's CD-ROM titles are becoming more and more popular. Dr. T's Music Software sent me a copy of *Dr. T's Sing-A-Long*. It combines music, animations, and lyrics to make singing a fun and educational experience. The disc contains 26 classic children's songs, including "Twinkle Twinkle Little Star" and "I've Been

Working on the Railroad." In truth, I'm almost looking forward to the next time my 3-year-old nephews visit, just to see how much they like this new disc. It is available for \$39.95.

Another children's title, *Who Wants Arthur?*, is available from Media Vision. This is essentially a children's book with story, pictures, text, and music. Arthur is an ordinary brown dog. A child can take in the story in many forms ranging from having it read to them without seeing the words, to reading the story independently while being able to click on any unknown words. It is a good educational and entertainment value for \$39.95.

While not on CD-ROM, Sound Source Unlimited sent me a sampling of their multimedia software. Most of their stuff consists of movie audio/video clips that are great for use in personal multimedia productions or for attaching unusual sound clips to your desktop functions. I've now got sound and video clips from *Star Trek*, *Star Wars*, *T2*, and the *Wizard of Oz*, and there are many other titles available. I also took a look at their *T2 Screen Saver*. This program just adds modules to your built-in Windows screen saver, so it's easy to use. Now, in addition to keeping my PC from being mediocre, the Terminator protects my monitor from screen burn-in.



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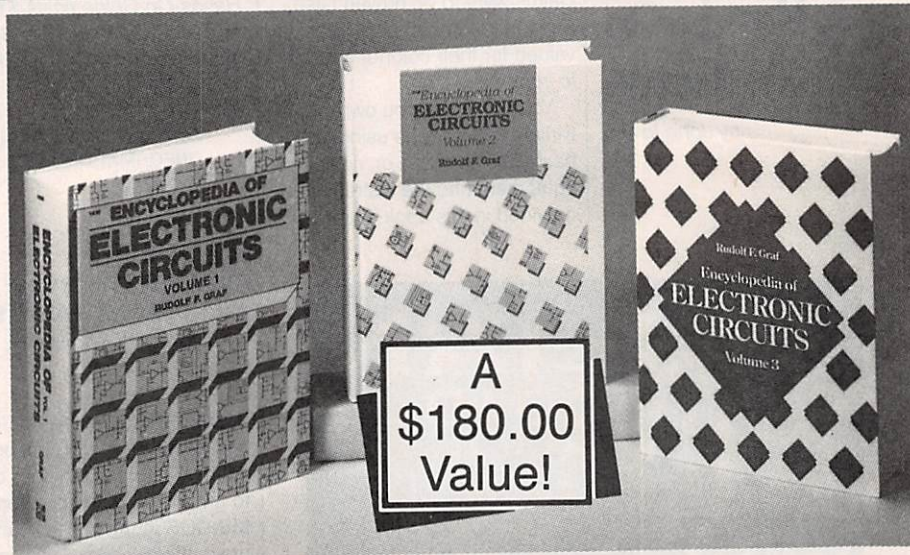
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by John Iovine

Almost 150 years after its discovery, electrophotography, commonly known as Kirlian photography, remains a subject of speculation and controversy. Some people believe that Kirlian photographs can reveal illnesses in plants and animals before any outward symptoms are evident. Even if those claims were to be proved false, Kirlian photographs would be valued for their colorful aesthetic appeal.

You can make your own Kirlian photographs using just basic photographic or video equipment and the instructions provided in this book. It contains

applications in medicine, industry, and the military. The book offers plans and instructions for building your own Kirlian device for less than \$25, and explores the "phantom leaf" aura that continues to baffle scientists. Full-color Kirlian photographs are included.

Kirlian Photography: A Hands-On Guide costs \$16.95 and is published by Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel: 1-800-233-1128.

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A CONCISE INTRODUCTION TO MICROSOFT WORKS

by N. Kantaris and P.R.M. Oliver

Written with the busy, non-expert person in mind, this book aims to help the beginner come to grips with Microsoft Works for MS-DOS in the shortest and most effective way. Fully updated to cover the improvements included in version 3.0, the book has an underlying structure that allows the reader to build upon the information presented in each chapter. Experienced Works users need not read the book cover-to-cover, but can start from any of the self-contained sections.

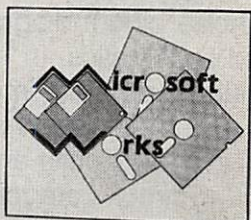
The book explains how to use the word processor to type, edit, print, and save documents. It describes how Works can be used to build up simple spreadsheet examples and then to edit, save, print, and retrieve them. It shows readers how to generate, edit, and print both single and multiple graphs. The book covers setting up, sorting, and searching through a database-management system, and how to use it to create top-

quality printed reports. To simplify long, repetitive tasks, the book explains how to create simple macros and how to customize the program to meet your own needs.

A Concise Introduction to Microsoft Works (order number

A Concise Introduction to Microsoft Works

N. KANTARIS & P. R. M. OLIVER



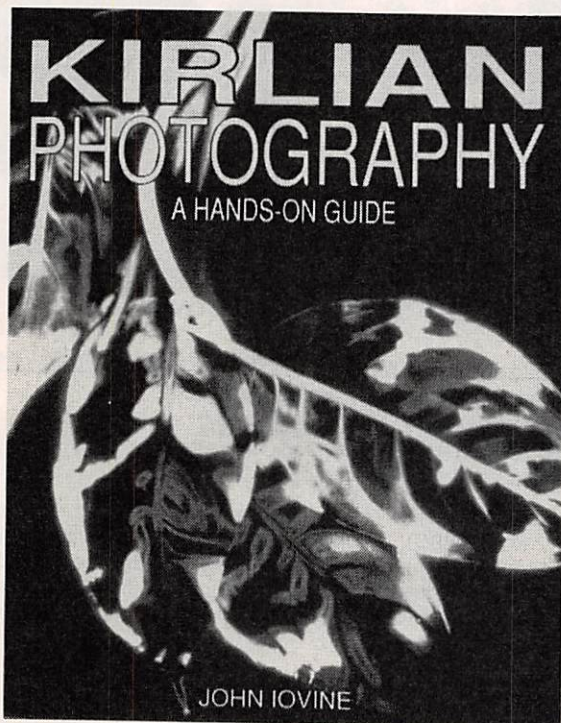
BP294) is available for \$6.95 plus \$2.50 shipping and handling from Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.

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OSCILLATOR PROBE CATALOG NO. 90

from Test Probes, Inc.

This 16-page catalog describes TPI's full line of high-performance oscilloscope probes. Highlights include a new differential probe for safe measurement of floating circuits to 700 volts and active FET probes. The catalog also features silicone-rubber multimeter leads designed to meet new industry safety standards, high-voltage probes, coax adapters, and adapter kits for in-series and between-series connection



step-by-step instructions on how to shoot all types of subjects, including human. Background material includes a history of electrophotography and a look at its possible ap-

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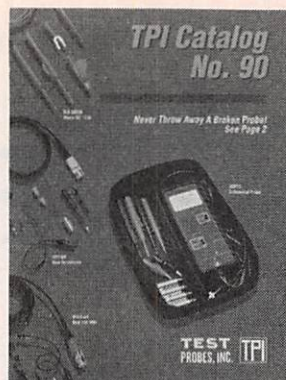
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of BNC, TNC, SMA, and five other connector types. A cross-reference chart lists economical replacement probes for all makes of oscilloscopes.

TPI Catalog No. 90 is free upon request from Test Probes, Inc., 9178 Brown Deer Road, San Diego, CA 92121; Tel: 800-368-5179; Fax: 619-535-1260.

CIRCLE 90 ON FREE INFORMATION CARD

POWER UP! How to Make Battery Adapters for Portable & Military Radios, and other Military & Non-Military Electronics

by Dave Strom

Readily available on the surplus market, military radios are rugged, versatile, well-designed, and easy to operate. It's no wonder that the surplus sets are used by amateurs, National Guard units, experimenters,



federal agencies, and survival groups. The only problem with them is that almost every type of portable and mobile military set requires a different, usually

hard-to-find, battery, designed particularly for that piece of equipment.

This book solves the problem of powering surplus military radios and electronic equipment. It shows how to easily make battery adapters for the many popular units, allowing the use of standard commercially-available batteries. The fully illustrated book contains detailed instructions and clear wiring diagrams that show exactly how to make adapters that can be used to power a wide variety of popular portable and mobile military radios. In addition, the book covers battery adapters for strobes, night scopes, radiac sets, detection/intrusion sets, and field telephones.

Power Up! is available for \$13.95 plus \$4 shipping and handling (\$5 to Canada) from CRB Research Books, Inc., P.O. Box 56, Commack, NY 11725; Tel: 800-656-0056 in continental U.S., or 516-543-9169. (New York residents please add \$1.53 state sales tax.)

CIRCLE 91 ON FREE INFORMATION CARD

BUILD YOUR OWN HOME THEATER

by Robert Wolenik

Home theater has changed the way we watch TV. Viewers are turning to large-screen sets, accompanied by surround-sound audio systems. If you've been thinking of updating your existing audio/video system or building a complete home theater from the ground up, this book can help you do it without spending a fortune.

The book describes exactly what components go into various home-theater systems—from the simple TV-stereo hook-up to a system complete with Dolby Pro Logic surround sound and even a satellite dish—and then helps you decide what to include in your home theater. It clearly explains the differences between direct-view, rear-projection, and front-projection televisions; Dolby Surround, Dolby Pro Logic, and THX; and other audio and video options.

The book also shows how to



fit all the electronics equipment into your home. Beginning with selecting an appropriate room, the book explains how to acoustically insulate it for the best possible performance, how to arrange speakers for true surround sound, how to shop for an entertainment center, how to choose colors and lighting that complement the system, and how to arrange furniture to maximize viewing pleasure. Numerous illustrations as well as photographs of real-life home theaters illustrate the concepts presented in the text.

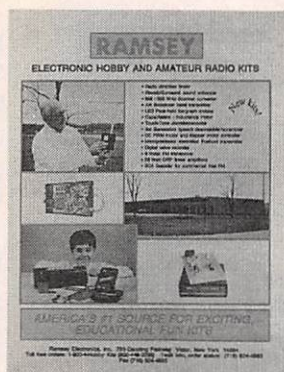
Build Your Own Home Theater costs \$16.95 and is published by Sams Publishing, 201 West 103rd Street, Indianapolis, IN 46290; Tel: 317-581-3500; Fax: 317-581-3500.

CIRCLE 95 ON FREE INFORMATION CARD

ELECTRONIC HOBBY AND AMATEUR RADIO KITS CATALOG

from Ramsey Electronics

This 20-page catalog contains an assortment of exciting, educational kits for the electronics hobbyist or student. The products range from fast and easy "Mini-Kits"—including a univer-



sal timer, a voice-activated switch, and a light-beam communicator—to VHF/UHF/FM transceiver kits. Other projects include QRP transmitters, active antennas, shortwave gear, a microwave motion detector, a radio direction finder, a TV transmitter, and an FM broadcast-band receiver. The catalog also offers test equipment, antennas, and radio accessories.

The Electronic Hobby and Amateur Radio Kits Catalog is free upon request from Ramsey Electronics, Inc., 793 Canning Parkway, Victor, NY 14564; Tel: 800-446-2295; Fax: 716-924-4555.

CIRCLE 92 ON FREE INFORMATION CARD

SOUTHPAW ELECTRONICS CATALOG 931

from Southpaw Electronics

Electronics hobbyists and technicians alike will find a wide variety of components and parts in this 22-page catalog. Included are LEDs, switches, piezo products, capacitors, transistors, replacement semi-



conductors, resistors, rectifiers, diodes, transformers, and more. Special buys are offered on several products, including quartz crystals, oscillators, shorting jumpers, and a jumperable assembly. The company offers a "frequent buyer bonus plan" that awards buyers with a bonus point (worth five cents on future purchases) for each dollar of merchandise ordered. Certain products—including grab-bag specials of assorted parts—earn double or triple bonus points.

Catalog 931 is free upon re-

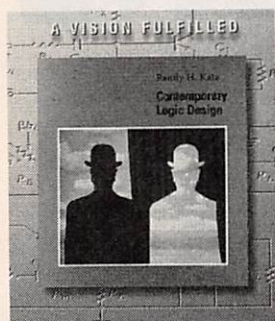
quest from Southpaw Electronics, P. O. Box 886, New Hyde Park, NY 11040-0311; Tel: 800-851-8870; Fax: 516-775-5091.

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CONTEMPORARY LOGIC DESIGN

by Randy H. Katz

This textbook offers an innovative approach to logic design that combines a superior introduction to design fundamentals with an in-depth look at today's state-of-the-art design technologies. Recognizing the hardware-design revolution brought about by CAD, rapid prototyping, and PLD's, the book demonstrates how each tool fits



in the design process. Numerous case studies, along with special "Practical Matters" sections, underscore the book's emphasis on the development of practical design knowledge. In addition, an extensive supplements package is available separately. The package includes almost 600 electronic transparencies, a complete instructor's guide, and hardware and software labs.

Contemporary Logic Design costs \$67.75 and is published by The Benjamin/Cummings Publishing Company, Inc., 390 Bridge Parkway, Redwood City, CA 94065; Tel: 800-950-BOOK.

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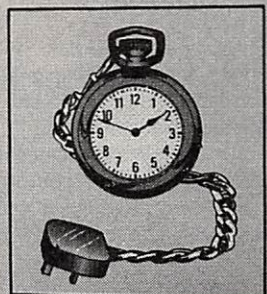
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by Owen Bishop

This book explores the ways in which electronics is applied to the measurement of time. The

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theory that it presents is backed by an array of practical construction projects for the beginning, as well as the advanced, builder. The projects cover many fields of interest, including basic time-keeping, laboratory-data gathering, high-precision timing, sports and games, music, and many other applications in and around the home. Each project includes a detailed circuit diagram and full explanations of how it works, how to build it, and how to troubleshoot it. All of the circuits are battery-powered, making

them safe to build and to use. Several are simple, low-cost projects aimed at the beginner and younger enthusiast. Because the projects make use of all of the more commonly available timing IC's, the book also acts as a reference to practical timing techniques.

Practical Electronic Timing (order number BP317) is available for \$6.95 plus \$2.50 shipping and handling from Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.

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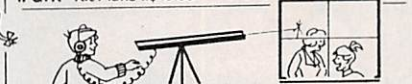
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Version 3 expands the selection of analog and digital parts by adding new components, including JFET's and MOSFET's plus controlled sources and switches. Real-world models

of RAM, and is available for MS-DOS and Windows PC's and Macintosh platforms.

Electronics Workbench costs \$299, including an analog and digital module. Existing customers can upgrade to the new MS-DOS version for \$79 or the Windows version for \$99. For further information, contact Interactive Image Technologies Ltd., 700 King Street W, Suite 815, Ontario, Canada M5V 2Y6; Tel: 416-361-0333 or 800-263-5552;

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also source up to 1000 ohms to use as a calibration device for other types of RTD's and even potentiometer settings.

The *Models 473 and 475*

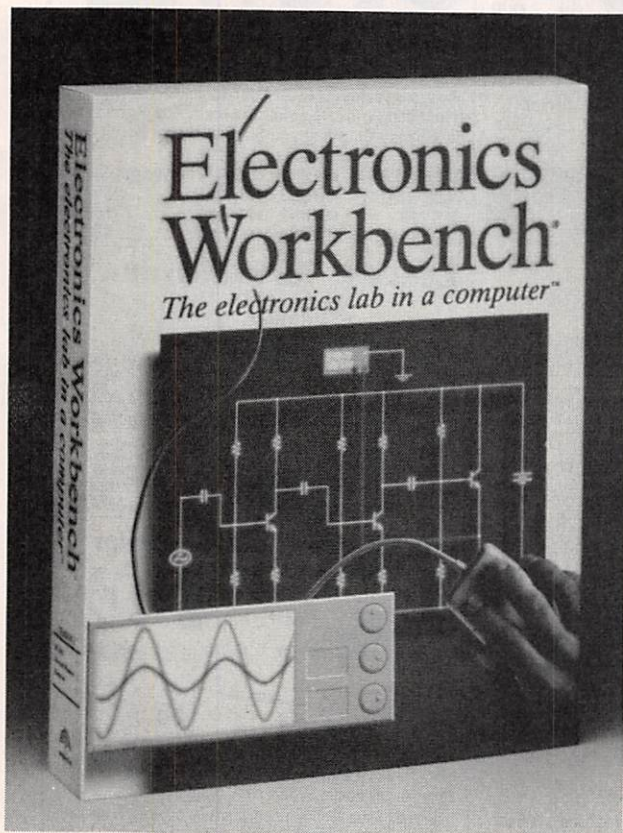


temperature-sensor simulators cost \$795 and \$895, respectively. For more information, contact *Wavetek Corporation*, 9145 Balboa Avenue, San Diego, CA 92123; Tel: 619-279-2200.

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that make all active components selectable by part number, as they are found in data books, have also been added. Version 3 can also support up to 16 MB

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Soldr-Pen, which provides advanced low-temperature/high-capacity heating in a micro-soldering hand piece, is included. More than 60 surface-mount and thru-hole tips are available to address a wide assortment of soldering problems. The ST 20 can be instantly expanded from production soldering to handle many specialized surface-mount and thru-hole repair tasks by adding other SensaTemp hand pieces.

The ST 20 soldering system costs \$189. For additional information, contact Pace Inc., 9893 Brewers Court, Laurel, MD 20723; Tel: 301-490-9860; Fax: 301-498-3252.

CIRCLE 103 ON FREE INFORMATION CARD

RUGGED CLAMP METER

Designed to meet the rigorous demands of on-site jobs, the *Fluke Model 30* clamp meter has been tested to withstand a six-foot drop. The Model 30 is well-suited for use by commercial, industrial, and residential electricians, as well as HVAC/R service technicians. Its tapered jaws with centered opening make it easy to access conductors in crowded junction boxes. The clamp meter conforms to the tough IEC 1010 safety standards.

The Model 30 measures AC current to 400A, AC voltage to 600V, resistance, and continuity.



It is more accurate and easier to read than similarly priced analog meters. A hold button freezes the display so that values can be read at the user's convenience. The clamp meter's 1.3% accuracy is specified for one year after calibration.

The Model 30 clamp meter costs \$99. For additional information, contact Fluke Corporation, P. O. Box 9090, Everett, WA 98206; Tel: 800-87-FLUKE; Fax: 206-356-5116.

CIRCLE 104 ON FREE INFORMATION CARD

CONVERTIBLE HEADPHONES

Jasco's Model 455 super-bass convertible headphones feature a unique design that allows the basic headphones to be transformed to over-ear design with the easy addition of convertible adaptors. The Model 455 also features an adjustable padded headband for a comfortable fit. Other features include a single



side cord with a gold-plated 1/4-inch adaptor and 40mm samarium cobalt magnets for super-bass sound.

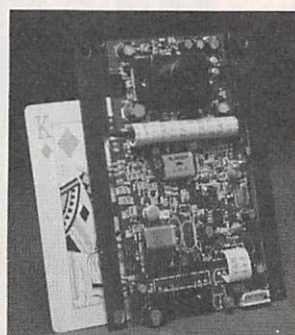
The Model 455 convertible headphones have a suggested retail price of \$31.99. For additional information, contact Jasco Products Company, Inc., P. O. Box 466, Oklahoma City, OK 73101; Tel: 405-752-0710.

CIRCLE 105 ON FREE INFORMATION CARD

MICRO VIDEO CAMERA

According to *Supercircuits*, its *PC-7* is the world's smallest color video camera. Made up of three PC boards interconnected by flexible ribbon-type cables, in its smallest configuration the *PC-7* would be a cube that measured approximately 2 1/4

inches. The CCD pickup and lens are mounted on a sub-board that can be separated. The camera can be left in a flat configuration, "cubed," or rest at a 90° angle from the imager with the lens pointed out the end of the enclosure. The tiny video camera has applications in computer image capture, desktop videoconferencing, live-action sports videography, covert investigations, and sur-



veillance. In addition, the *PC-7* could be mounted in a radio-controlled car or airplane to record live-action R/C video.

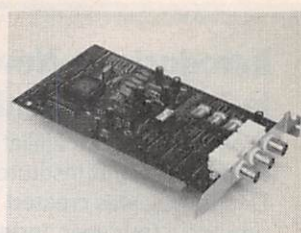
With more than 270,000 pixels and 350 lines of resolution, the *PC-7* offers performance superior to standard VHS and 8mm camcorders and approaches the quality of Hi8 and Super VHS (which have 400 lines of resolution). It has a 2-lux low-light rating. Other features include auto gain control, auto white balance, auto black balance, and electronic automatic shutter.

The *PC-7* video camera, fully assembled, costs \$369.95 plus \$7 shipping. For more information, contact Supercircuits, 13552 Research Blvd. #B, Austin, TX 78750; Tel: 512-335-9777.

CIRCLE 106 ON FREE INFORMATION CARD

DIRECT DIGITAL SYNTHESIZER PC CARD

Novatech Instruments' Model DDS3 PC is a 12-MHz synthesized-signal source on a plug-in card for use in PC XT and PC AT or later ISA-bus computers. It provides 5-ppm accuracy and 10-ppm/year stability. The use of modern digital technology allows the *DDS3 PC* to offer spectral purity comparable to that of older instruments



that cost thousands of dollars. For example, the phase noise is less than -90 dBc at 1-kHz offset, spurious signals are below -45 dBc, and harmonics are less than -40 dBc. Output amplitude is 12 V_{pp} into an open circuit and can be attenuated in 10-dB steps to 70 dB.

The *DDS3 PC* can simultaneously generate sinewave and TTL/HCMOS clock signals from 2 Hz to 12 MHz in 2-Hz steps. It comes with a C-language program that runs under DOS and makes it easy for users to set frequency and attenuation or to sweep through a set of frequency, attenuation, and dwell-time settings. A driver is also available for a third-party, Windows-based ATE programming environment.

The *DDS3 PC* 12-MHz direct digital synthesizer card costs \$399. For more information, contact Novatech Instruments, Inc., 1530 Eastlake Ave. E., #303, Seattle, WA 98102; Tel: 206-328-6902; Fax: 206-328-6904.

CIRCLE 107 ON FREE INFORMATION CARD

LED FLASHLIGHTS

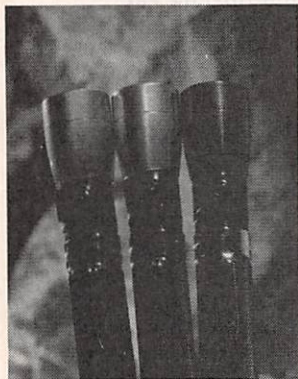
Three compact flashlights from *Ledtronics* use special LED lamps to provide color-controlled, low-intensity illumination for a wide variety of industrial and recreational purposes. Each is made with a rugged, splash-proof, anodized-aluminum case and uses AA batteries that will last at least 15 times longer than in incandescent-type flashlights. The LED lamps, with a life of more than 100,000 hours, are available in three intensities (safelight, medium, and full), eight visible colors (ultra-red through blue), and three infrared wavelengths.

The *Stealth-Lite* is a wide-beam flashlight that does not reduce night vision even when the user looks directly at the beam, making it well-suited for

amateur and professional pilots, boaters, or navigators.

The *Specter-Lite* is a narrow-beam flashlight aimed at professional darkroom workers, astronomers, film-processing technicians, radiology technicians, and manufacturers of light-sensitive materials who require illumination while maintaining safelight conditions. Its solid-state LED lamp allows tight control of beam width, illumination intensity, and color-temperature.

The *Phantom-Lite* is a wide-



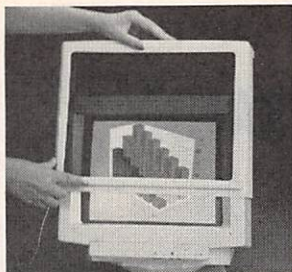
beam, pen-light style flashlight that can be used by military police, drivers, or theater-goers who need illumination without reflected glare.

For more information on the *Stealth-Lite*, *Specter-Lite*, and *Phantom-Lite* LED flashlights, contact Ledtronics, Inc., 4009 Pacific Coast Highway, Torrance, CA 90505; Tel: 310-534-1505; Fax: 310-534-1424.

CIRCLE 108 ON FREE INFORMATION CARD

MONITOR ANTI-GLARE FILTERS

The *Secure-View* anti-glare filter from *Kantek/Spectrum* combines 99% glare reduction with an innovative design that restricts the peripheral view of material on the screen. That provides a practical means of controlling access to sensitive information in a crowded office environment. The filter is made of high-quality, optically pure glass that contains multiple thin-film anti-radiation coatings on each side. Anti-Radiation versions of the *Secure-View* filter have an additional coating and grounding cord that block up to 99.999% of ELF/VLF E-field ra-



diation, and 100% of static.

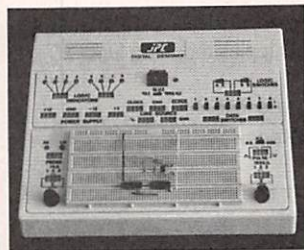
"Universal" models can be adjusted to fit most 12-15-inch VDT's and installs in seconds without tools. "Spectrum-Contour" models give irregular-shaped and curved VDT's a customized look, fitting snugly around the front of the monitor.

Secure-View filters are priced starting at \$169. For more information, contact Kantek Inc., 15 Main Street, East Rockaway, NY 11518; Tel: 516-593-3212; Fax: 516-593-3295.

CIRCLE 109 ON FREE INFORMATION CARD

DIGITAL CIRCUIT DESIGNER

JPC International's Model TD107 digital circuit designer comes complete with everything needed to design, build, and test digital electronic circuits. It's easy to build, modify, expand, and dismantle circuits without



soldering, by simply inserting the components into the built-in breadboards. Those breadboards accept DIP IC's and virtually all active and passive components. The Model TD107 comes with breadboards that total 1380 tie points, which can accommodate up to 16 14-pin DIP IC's, and can be expanded up to 2020 tie-points, to accommodate up to 24 14-pin DIP IC's. The digital circuit designer is housed in a sturdy high-impact plastic case and includes regulated +5VDC, +12VDC, and -12VDC power supplies; dual-frequency (0.5-

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and 500-Hz) pulse generator with outputs in either high-to-low or low-to-high transitions; complementary clock generator; 60-cycle squarewave; logic probe; eight switchable high or low data switches; eight LED logic indicators; two complementary debounced logic switches; and 1k and 100k potentiometers.

The Model TD107 digital circuit designer costs \$159.95. For further information, contact JPC International, Inc., P.O. Box 55, Agoura Hills, CA 91301; Tel: 818-707-1514; Fax: 818-707-7327.

CIRCLE 110 ON FREE INFORMATION CARD

RS-232 TO RS-485 CONVERTERS

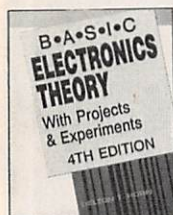
Two plug-in units from *ICS Electronics Corporation* convert RS-232 serial signals into RS-422 or RS-485 compatible signals. The *Models 485M* and *485F* converters are available with male and female connectors, respectively, and are designed to plug directly onto any device with a 25-pin



RS-232 serial port. The units handle baud rates over 114.2 K baud and extension distances greater than 1200 meters. Both converters provide greater noise immunity and longer distances between serial devices than is possible when using standard RS-232 signals. The Model 485M is factory set as a DCE device while the Model 485F is set as a DTE device, but each can be easily configured in the field to operate as either DCE or DTE device. Both units accept +5 to +14 VDC power and are polarity protected.

The Model 485M and 485F converters each cost \$150. A companion +12VDC power supply is available for \$12. For further information, contact ICS Electronics Corporation, 744 South Hillview Drive, Milpitas, CA 95035; Tel: 408-263-5500; Fax: 408-263-5896.

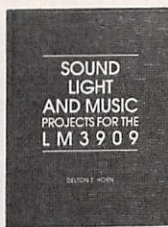
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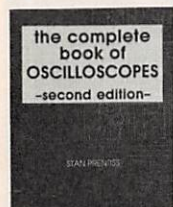
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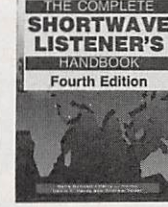
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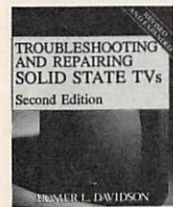
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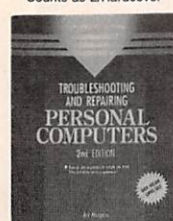
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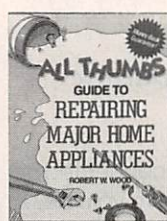
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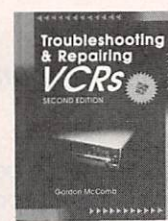
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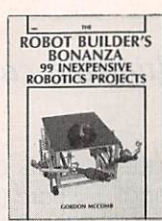
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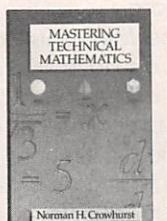
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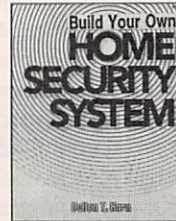
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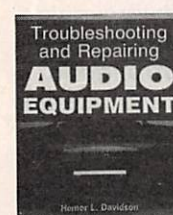
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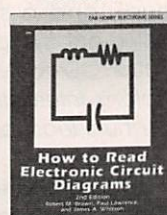
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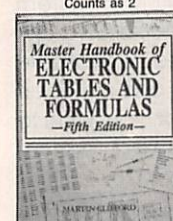
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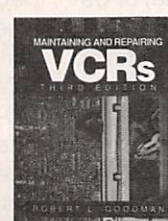
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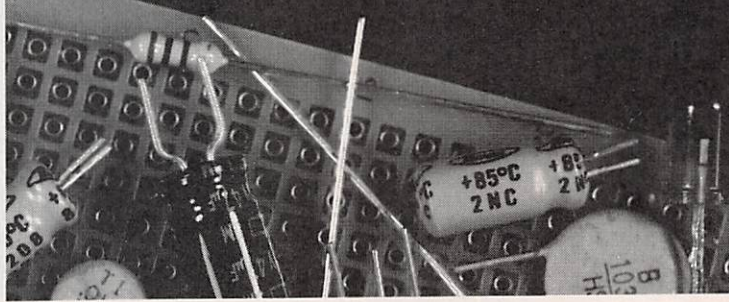
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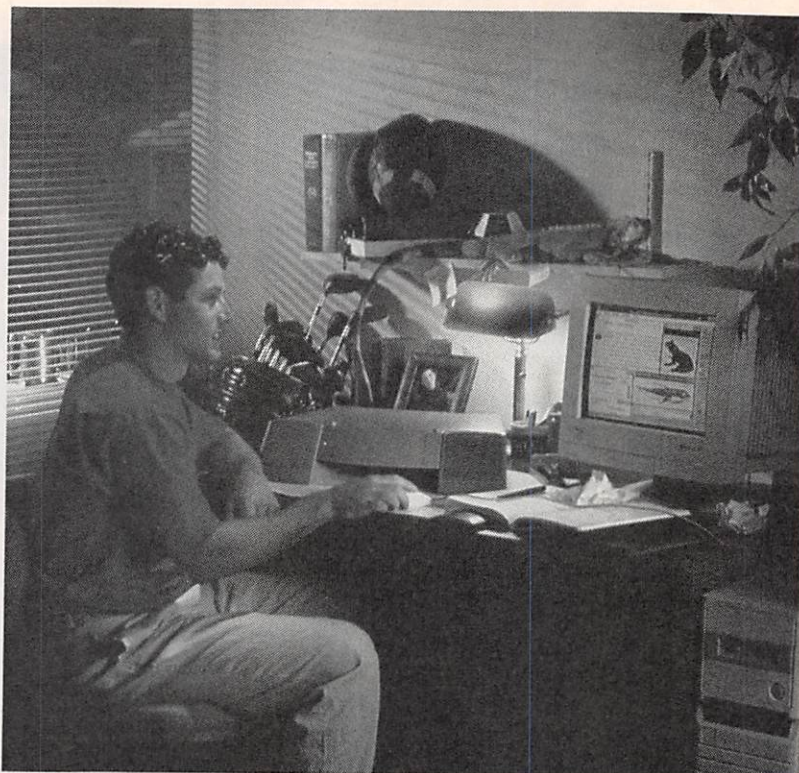
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CIRCLE 119 ON FREE INFORMATION CARD

An easy way to add multimedia capabilities to any PC or compatible

Multimedia is currently the hottest topic in personal computing. These days, even low-end PCs are being outfitted with CD-ROM drives. There are a lot of reasons for that: the prices of hardware and software have come down considerably; a number of applications, especially entertainment, education, and research titles, have been optimized for CD-ROM; and the growing size of even non-CD-ROM titles make CD-ROM an ideal distribution medium.

That said, I decided it was time to add a CD-ROM to my own computer. Unfortunately I had a problem: my PC's case has only three external bays, which were taken up by two disk drives and a tape-backup unit. The most practical solution was to add an external CD-ROM, and that's what I did. I installed the *Memphis* from Media Vision (47300 Bayside Parkway, Fremont CA 94538; Tel. 800-845-5870).

The Memphis. The Memphis is a complete, integrated, MPC level-2 multimedia upgrade system. It consists of a double-speed multisession,

NEC CD-ROM drive; a 16-bit sound card (based on Media Vision's popular Pro AudioSpectrum 16); a pair of amplified speakers; all necessary cables and software; two bundled applications (more on that later); and everything else you need to get started right away.

The Memphis is being marketed as a consumer-friendly, multimedia solution. Toward that end, it has a couple of things that set it apart from most other external CD-ROM upgrade kits. For one, it features a higher degree of styling than is usual. It is housed in an attractive gray case with graceful lines. The drive itself is hidden behind a drop-down door.

The matching speakers are designed so that they can be mounted horizontally on the drive case, or detached and placed as much as six feet away for enhanced stereo sound. If detached, they can be placed either horizontally or vertically using included speaker stands.

Also, the unit is designed so that it can be used as an audio-CD player—even with your computer turned off. In fact, the drive does not even have to

be connected to a computer; the power, volume, and drive-transport controls are all located on the front of its case.

The Memphis comes packaged with a suite of DOS and Windows utilities and applications. Among them are programs that allow you to play audio CD's, record WAV (sound) files, play MOD (music) files, and more. Also included is voice-recognition software, a microphone, an installation manual, and a software guide. Rounding-out the package are two popular CD-ROM applications: *Compton's Interactive Encyclopedia* and *Arthur's Teacher Trouble*.

System Requirements and Specifications. The Memphis requires at least a 386SX with 640K of system memory, DOS 5 or higher, a hard disk with at least 12 MB free, 2 available DMA and IRQ settings, and an open 16-bit expansion slot. If you wish to meet minimal MPC level-2 requirements you need a 486SX/25, 4 MB of system memory (8 is recommended), a 160-MB hard drive, and an SVGA video card.

The Memphis CD-ROM drive is a double-speed, multisession SCSI unit with a rated data-transfer rate of 300 K/sec, a 350-ms seek time, and a 64K cache. The sound card is a dedicated version of the Pro AudioSpectrum 16, which is among the more popular sound cards on the market. It features 16-bit PCM recording and playback, a midi interface, a 20-voice FM synthesizer, and more, and is fully Sound Blaster and AdLib compatible. An on-board connector allows you to use the card to interface additional SCSI devices (such as scanners, hard drives, etc.).

Easy Installation. The Memphis is billed as an easy-to-install multimedia solution. In fact, it would be hard to imagine an easier way to add multimedia to a PC-compatible system. The problem is, adding *anything* to a PC can be a pain; we'll explain further in just a moment.

Unlike internal multimedia upgrades, the only thing that goes into your computer is the interface/sound card. Installation is a simple matter of opening your computer, finding an available 16-bit slot, removing its back panel, and inserting and securing the card. While there are on-board jumpers, most users will not need to change them from their factory defaults; interrupt (IRQ) and DMA-channel selections are done with software—a very welcome feature.

Once the card is in place, the balance of the hardware installation should proceed very easily. The card is connected to the drive using a special dedicated cable. Connect the speakers and the small external power supply, and you are done with the hardware installation.

Software installation is done using the Memphis Quick Start Installation disk and the Memphis Installation CD-ROM. The installation programs ask you some questions, select what it thinks are available IRQ and DMA channels, modifies system files so that your PC will recognize the Memphis, and installs various drivers and multimedia applications.

If all goes well, you are now ready to enter the world of multimedia. If you encounter problems, there is a fairly good troubleshooting guide, and a section of commonly encountered problems, questions, and solutions in

the installation manual. Unfortunately, I needed to find out just how good this section was.

The number-one problem encountered in adding peripherals to a PC is the dreaded interrupt (IRQ) conflict. PC hardware and software vendors are hard at work trying to eliminate that problem, which is caused by the PC's now archaic interrupt structure. Unfortunately, until the promised "Plug-n-Play" standard becomes reality (perhaps by sometime next year), IRQ's will be around to bite us and no PC installation can be considered truly "easy."

In my case, a problem did not become apparent until the next time I went to use my modem—one of the interrupts selected by the Memphis was the same as used by my internal fax/modem. Since the device was not active during the Memphis installation, the program had no way of knowing it was there. (Of course, if I had been paying closer attention during the installation process, and if I had remembered which interrupt the modem used, I could have prevented the conflict then, but such is life.)

With most adapter cards, changing an IRQ setting would involve opening the PC, pulling the offending card, and changing the position of a tiny jumper or switch. Fortunately, as previously mentioned, the Memphis settings are software controlled, making the job as painless as could be. Also, the manual does a good job of helping you diagnose IRQ and DMA problems, and walks you through several ways of solving them.

Summary. I've been using the system for several weeks now, and it, and everything I've run on it, has worked flawlessly. That includes a couple of entertainment titles that have been known to give lesser systems fits. At a suggested list price of \$999 (street prices are, of course, considerably lower), the Memphis is not the least expensive multimedia solution out there, but when you consider its superior performance, ease of installation and use, attractive styling, and versatility, it would be hard to find one that offers a better value.

For more information on the Memphis, contact Media Vision directly, or circle No. 119 on the Free Information Card. ■

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CIRCLE 162 ON FREE INFORMATION CARD

PRODUCT TEST REPORTS

By Len Feldman

Mitsubishi HS-U57 Video Cassette Recorder

To give you an idea of how feature laden the HS-U57 VCR from Mitsubishi is, let us start by mentioning that the owner's manual accompanying the VCR is 159 pages long, including a 3-page index! In addition to the usual programming capabilities (up to 8 events within a one month period), one-touch recording, and automatic channel programming, this remarkable VHS VCR has a number of special features. What Mitsubishi calls its ViewPoint On-Screen Operating System provides easy access to VCR features with simple on-screen instructions featuring calendar programming.

A "Name The Channels"

"Intelligent Picture Control" automatically sharpens and softens the detail of the picture during playback to create the best possible picture at all times. Edit Search allows you to quickly locate a frame on the tape while recording for more precise editing. "Indexing" magnetically marks program points on a tape while recording, allowing you to quickly find them later. "Quick Program" provides a fast, simple way to program the VCR to record. A "Mix Switch" allows you to add commentary to existing tape soundtracks and to listen to four different audio tracks: stereo, mono, left, and right. S-VHS quasi playback lets you play back

power switch, an eject button, the video-cassette slot, an elaborate front-panel fluorescent display, and a hinged control-panel door that, when lowered, discloses the remaining controls and terminals. They include an "Edit" terminal; video- and audio-input terminals; a VCR A/B remote-control switch; video- and audio-dubbing switches; an input button; an audio-monitor button; a display-mode button; a VCR/TV switch; a recording-speed button; one-touch recording controls; the audio "Mix" switch record-level and balance controls; rewind, play, fast-forward, stop, pause, and record buttons; a channel scanning button; and the one-key program button that allows you to program the VCR right at the control panel instead of via the more elaborate remote control that is supplied with this product.

The rear panel of the VCR contains "Antenna In" and "Antenna Out" terminals, a channel-3/channel-4 switch, an "Edit" terminal, audio- and video-input and -output terminals; and "A/V Network" terminals that enable you to use the remote control with other Mitsubishi components.

In addition to duplicating the main controls found on the front panel of the VCR, the remote control contains the adjust and shuttle rings, index buttons, numbered buttons for directly accessing channels, the one-touch recording button,



CIRCLE 120 ON FREE INFORMATION CARD

The Mitsubishi HS-U57 videocassette recorder is shown here with its supplied remote control.

feature lets you name any channels you have programmed. The name you select appears on-screen when you change channels on the VCR. An adjust dial and shuttle ring allows for precise control for editing and searching functions.

tapes recorded in Super VHS (S-VHS) with standard resolution, even though this machine is not an S-VHS model.

CONTROLS

The front panel of this VCR contains the usual

TEST RESULTS—MITSUBISHI HS-U57 VCR

Specifications	PE Measured
Video frequency response @ 2.0 MHz	-4.33 dB
Video signal-to-noise ratio	
Chroma AM/FM	44.5db/42.7 dB
Luminance (100/50/10 IRE)	47.0db/57.0db/46.5 dB
Hi-fi audio output/THD	2.26 volts/3.0%
Hi-fi flutter (average/peak)	0.01%/0.012%
Conventional audio out/THD	0.47 volts/3.0%
Conventional flutter (average/peak)	0.14%/0.16%
Audio signal/noise ratio	
Hi-fi	87.6db
Conventional	49.6db
Audio response	
Hi-fi	20Hz-20 kHz
Conventional	64Hz-14.2 kHz
Audio THD @1kHz	
Hi-fi	0.15%
Conventional	0.53%
Stereo-decoder signal-to-noise ratio/THD	
Stereo	60.6 db/0.91%
Mono	60.8 db/0.34%
Stereo separation	28.5 dB
Power requirement	27.5 watts
Weight	12.5 lbs.
Fast forward time (T-120 tape)	2 min. 30 sec.
Rewind time (T-120 tape)	3 min.01 sec.
Dimensions (H x W x D, inches)	3 3/4 x 16 1/16 x 13 1/2
Suggested Retail Price:	\$699.00

and buttons that allow you to control two Mitsubishi VCR's. Also found there are audio and video function buttons used to adjust the sound and picture, a "Cancel" button, a mute button, and a "Quick View" button used to activate the quick search feature.

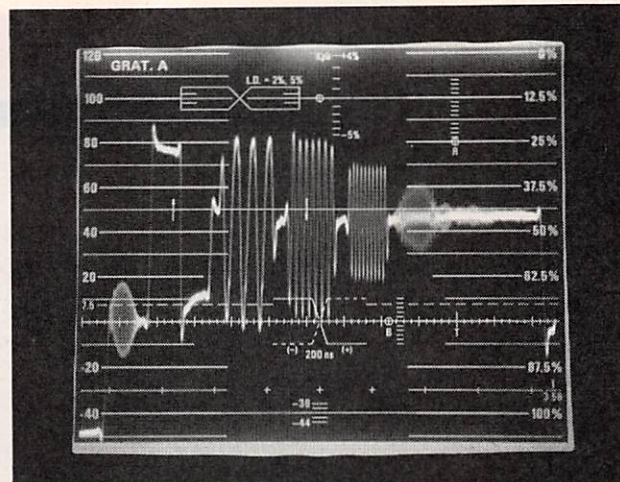
TEST RESULTS

All tests and performance measurements for this VCR were conducted by the Advanced Product Evaluation Labs (APEL) using the SP speed of the machine. Frequency response was measured using a multiburst test signal. At 2.0 MHz, the video-frequency response was measured at -4.33 dB referenced to a 0 dB reading at 0.5 MHz. The AM red-field chroma (color) signal-to-noise ratio measured 44.5 dB, while the PM (phase modulation) signal-to-noise ratio was 42.7 dB. The luminance signal to noise ratio measured between 47.0 and 46.5 dB, depending upon the lumi-

nance reference level.

The audio tracks for this VCR can be recorded using the VHS-hi-fi mode as well as using conventional edge-track audio recording. In the hi-fi mode, an output of 2.26 volts was measured for a distortion level of 3%. The average and peak flutter in this mode measured 0.01% and 0.012% respectively. The A-weighted signal-to-noise ratio in the hi-fi audio-recording mode was an impressively high 87.6 dB. By contrast, using the conventional audio-recording tracks, signal-to-noise measured only 49.6 dB, which is typical of this type of audio recording for VCR's. Flutter, using the conventional audio-recording mode, measured an average of 0.14%, and had a peak value of 0.16%, while the audio-output voltage measured 0.47 volts for a 3% distortion level.

The audio-frequency response using the hi-fi recording mode extended



The video frequency response of the unit was measured using a multiburst test signal.

over the full audio spectrum, from 20 Hz to 20 kHz; using the conventional audio recording system, the -3 dB roll-off points occurred at 64 Hz and 14.2 kHz. At a -10-dB record level, harmonic distortion measured 0.15% at 1 kHz when recording audio in the hi-fi mode, while for conventional audio recording, the distortion reading at the same frequency was 0.53%.

Since this VCR records audio stereophonically, it has a built-in stereo-decoder section to take care of recording TV shows that are transmitted with stereo audio. The A-weighted signal-to-noise ratio measured 60.6 dB in the stereo mode and 60.8 dB in the mono mode. Total harmonic distortion in stereo, at a level of -20 dB, measured 0.91%, while total harmonic distortion in mono was 0.34%. The stereo separation at mid-frequencies measured 28.5 dB.

The Mitsubishi HS-U57 consumed 27.5 watts of power and the product weighs approximately 12.5 pounds. Fast-forward winding time for a 2-hour tape was 2 minutes and 30 seconds, while the fast-rewind time was 3 minutes and 1 second. During fast-winding

operations, the counter on the VCR display disappears and reverts to "time remaining" on the cassette.

HANDS-ON TESTS

Despite the length of the owner's manual supplied with this VCR, we found actual operation to be fairly easy, thanks to the "plain-English" on-screen menus. The manual's third and fourth chapters are arranged so that you need only read Chapter 3 for more common VCR operations (including all the programming methods and options). Chapter 4 is devoted to the more advanced features, such as searching techniques, using the adjust and shuttle dials, dubbing and editing, tracking adjustment, and the like. Chapter 5 is devoted to trouble shooting and, happily, in our hands-on use tests of the product we never had to refer to that chapter.

In our opinion, considering its performance and features, the Mitsubishi HS-U57 offers an excellent value at its suggested retail price of \$699.00. For more information, contact Mitsubishi (5757 Plaza Dr., Cypress, CA 90603) directly, or circle No. 120 on the Free Information Card.

THINK TANK

By John J. Yacono

Addresses and Questions

As you might remember, our ongoing topic has been IC's; those wonderful black boxes that have become the mainstay of our hobby. I chose that topic to help vacuum-tuber's with renewed interest and newcomers to the electronics hobby as well.

One thing both those groups need, which I couldn't possibly provide in this column, are sales contacts (where they can purchase parts) and data sheets or books. However, what I can do is present the customer-relations addresses for the suppliers of 54xxx and 74xxx series IC's. That way you can contact them yourselves for data and purchasing information.

I would recommend that everyone approach them in a business-like manner for the best results. In other words, type a letter (don't try just calling or scribbling a note) to each company of interest. Each letter should clearly and briefly explain what you need (say, a local distributor or a data sheet). Don't overwhelm them with your technical savvy, personal experiences, or current hobby interests—chances are that the person who reads your letter is not technically inclined anyway. If you are a part of the electronics industry, I suggest using company stationery for impact. If you are more or less just a parts consumer, while you might receive fewer responses to your requests, I'm sure they will be more than satisfactory in scope and number to fill your needs.

74xxxx and 54xxxx Manufacturers

Advanced Micro Devices, Inc.
901 Thompson Place
Sunnyvale, CA 94088

Allegro Micro Systems, Inc.
363 Plantation St.
Worcester, MA 01605

Cypress Semiconductor Corp.
3901 North First St.
San Jose, CA 95134

GEC Plessey Semiconductors
1500 Green Hills Rd.
Scotts Valley, CA 95066

GoldStar Technology, Inc.
3003 N. First St.
San Jose, CA 95134

Harris Corp.
Semiconductor Sector
P.O. Box 883
Melbourne, FL 32902-0883

Hitachi America, Ltd.
2000 Sierra Point Parkway
Brisbane, CA 94005

Ideal Semiconductor
46721 Fremont Blvd.
Fremont, CA 94538

Integrated Device Technology, Inc.
2975 Stender Way
Santa Clara, CA 95054-3090

Lansdale Semiconductor, Inc.
2929 South 48th St., Ste. #2
Tempe, AZ 85282

Maxim Integrated Products
120 San Gabriel Dr.
Sunnyvale, CA 94086

Micrel
1849 Fortune Dr.
San Jose, CA 95131

Mitsubishi Electronics America
1050 East Arques Ave.
Sunnyvale, CA 94086

Motorola Semiconductor Products
5005 East McDowell Rd.
Phoenix, AZ 85008

National Semiconductor Corp.
2900 Semiconductor Dr.
Santa Clara, CA 95051

NJR Corp.
Div. of New Japan Radio Co. Ltd.
340-B East Middlefield Rd.
Mountain View, CA 94043

Panasonic Industrial Co.
Matsushita Electric Corp. of America

1600 McCandless Dr.
Milpitas, CA 95035

Performance Semiconductor Corp.
610 E. Weddell Dr.
Sunnyvale, CA 94089

Philips Semiconductors
811 East Arques Ave., POB 3409
Sunnyvale, CA 94088-3409

Quality Semiconductor
851 Martin Ave.
Santa Clara, CA 95050

Rochester Electronics, Inc.
10 Malcolm Hoyt Dr.
Newburyport, MA 01950

Rockwell International
4311 Jamboree Rd., POB C
Newport Beach, CA 92658-8902

Samsung Semiconductor, Inc.
3655 North First St.
San Jose, CA 95134

SGS-Thomson Microelectronics, Inc.
1000 E. Bell Rd.
Phoenix, AZ 85022

Sharp Electronics Corp.
5700 N.W. Pacific Rim Blvd.
Camas, WA 98607

Siliconix, Inc.
2201 Laurelwood Rd.
Santa Clara, CA 95054

STC Components
Maidstone Rd.
Sidcup, Kent, United Kingdom
DA14 5HT

Teledyne Components
1300 Terra Bella Ave., POB 7267
Mountain View, CA 94039-7267

Texas Instruments, Inc.
POB 655303
Dallas, TX 75265

Toshiba America Electronic Components, Inc.
9775 Toledo Way
Irvine, CA 92718

Unicorn Microelectronics Corp.
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Santa Clara, CA 95054

Universal Semiconductor, Inc.
1925 Zanker Rd.
San Jose, CA 95112

VTC, Inc.
2800 Old Shakopee Rd.
Bloomington, MN 55425

While it's a long shot, I secretly hope that manufacturers will sense enough interest in the hobbyist-level market to become more low-volume purchase friendly. Frankly, I think it would be incredible press for one of those companies to bill themselves as the "Electronics Educator" of America's youth, and distribute data and parts in reasonable quantities at an affordable cost. Surely, if companies can give away parts to potential customers here and abroad, they can sell parts at cost to the potential industry leaders of tomorrow right here at home. Frankly, judging by the amount of correspondence I receive from readers looking for parts from non-volume dealers, I'd say it would be good business sense, too—especially now in the *neo* cold war where marketing means survival.

Well, that's my pitch for this month. I hope you'll be pleased with the completeness of the list, which was the result of pretty thorough research. Use it wisely, and only for good.

Now let's get to some mail of our own. This month's letters are a combination of requests for help and corrections.

IMAGINARY PROBLEMS

I have enjoyed **Popular Electronics** for many years. I have some back issues from the 50's and 60's that I bought while in high school.

While I enjoyed Charles Hansen's article "Wire!" (in the September, 1993 issue), there is an impedance formula on page 61 with a term that is not defined, a lower case "j." I suspect that that term is frequency dependent even though " Ω " is defined as frequency dependent in the article.

Could you define that

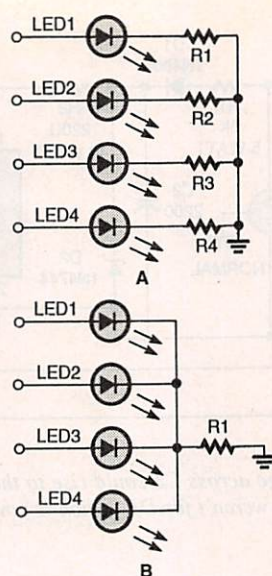


Fig. 1. Are these circuits equivalent? If not, under what conditions are the differences unimportant?

term for me. Thanks for years of good information and great reading.

—Lloyd Hansen, Clinton, MT

I'd be glad to, Lloyd. The letter *j* stands for the "primary imaginary number," a constant. In most math texts, it is represented as an "i" (which might be more familiar to you). The actual number is the square root of -1 , which cannot be a positive 1 (because a positive 1 times a positive 1 yields a positive 1, not a -1) and it cannot be a negative 1 (because -1 times -1 also yields a positive 1). If it's not positive or negative then it's not what they call a "real" number in math. Thus, the name "imaginary" number.

Like the normal number 1, *j* is used as the first digit of an entire number system: the imaginary number system. Imaginary numbers are written as regular numbers times *j*. For example, imaginary 2.3 is written 2.3*j*. Imaginary numbers can be combined with real numbers to form "complex"

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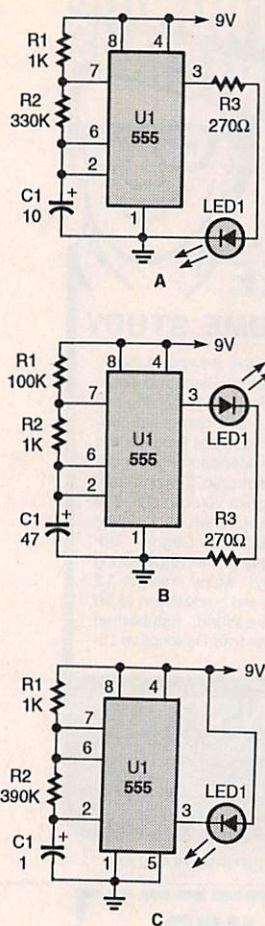


Fig. 2. The circuits in A and B might work okay with a higher value for R1, but the circuit in C is trouble from the get go.

numbers. For example, $4.1 + 2.3j$ is a complex number that has a real component of 4.1 and an imaginary part with a value of 2.3. Actually, adding the numbers 4.1 and 2.3; would have no meaning, because they are from entirely different number systems.

In electronics, complex numbers are used to describe properties that are a combination of directly and indirectly measurable qualities. For example, a part's impedance consists of a resistive component (which can be measured with the part inactive) and a reactive component (which can only be arrived at by measuring the impedance at a given frequency and the resistance at DC,

and then doing some math). Using complex numbers, we can easily write both portions of such quantities next to one another and yet keep them mathematically separate.

PROPER CONDITION

Regarding the January, 1993 problem with the air-conditioned, split-level house, might I suggest moving the thermostat upstairs, and installing an electric damper on the downstairs duct. Wire the damper to the downstairs thermostat.

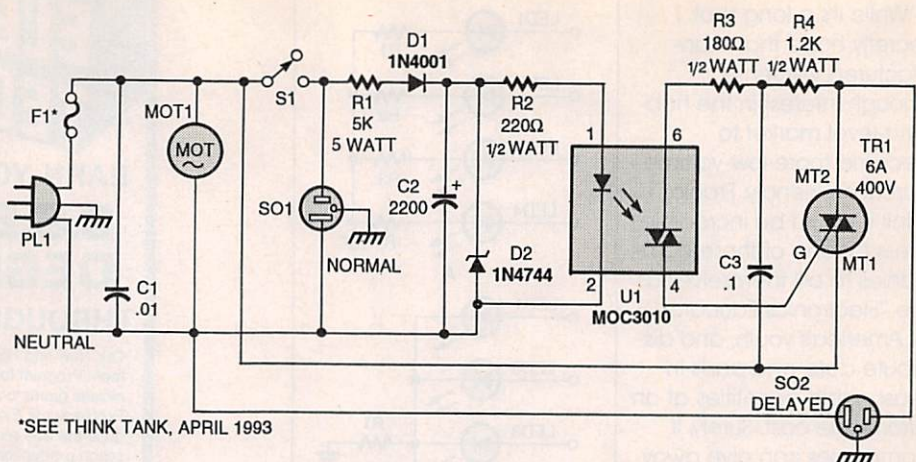
When it gets cool downstairs, the damper closes, but the air conditioner continues to cool upstairs, until it is cool as well. I've done this on several split floor-plan houses here in South Florida, and it works well.

By the way, you can also switch the downstairs "zone" off when there is no one downstairs. For example, at night, assuming the bedrooms are upstairs. That would save a large portion of your cooling bill.

—J. Deringer, Lantana, FL
While I don't have central AC, your ideas certainly sound feasible. Thanks for your input.

???

I have been meaning to



*SEE THINK TANK, APRIL 1993

Fig. 3. If a fault occurs, the voltage across C2 could rise to the point that that capacitor fails, if it weren't for D1, which is now included in this revised circuit.

send you a letter for quite some time now. I hope that you have a reply for each of my questions. In schematic diagrams like the one in Fig. 1A, would you not be able to rearrange it to look like Fig. 1B? If not, why?

In the June, 1993 issue of *Popular Electronics*, on page 77, is there not a way to make the circuit run 10- to 100-watt fluorescent tubes? Also, is there a Canadian substitute for the TL430C item that is in the same article?

Last, is there any way to convert a unknown waveform into square wave of the same frequency?

—Stephen Joseph, (address withheld)

If each LED is mutually exclusive (only one is lit at any given time), and the resistors and LED's are all the same and fed with the same voltage, then the circuits in Fig. 1 will operate similarly. If the LED's have different current requirements or receive different source voltages, then multiple resistors must be used to tailor the current through each LED. However, if the number of LED's lit at a given time varies, calculating the best value for R1 in Fig. 1B would become diffi-

cult: it would probably permit too much current to flow when only one LED is on, and too little current with more than one on.

I can't answer your second question off the cuff. Try writing to the author of the letter in care of me here at the magazine and I'll forward it to him in case he has any input. With regard to the TL430C, I can't find it in any of my databases. I'll have to assume that it's a discontinued part (again the author of that letter might be able to help).

Last, the easiest way to convert an unknown wave into a square wave is to use a comparator to detect when the unknown wave crosses a given voltage. For that, connect the comparator to an appropriate power source, connect one input to the unknown wave's source, and the other input to the reference voltage. Every time the unknown waveform crosses the reference voltage the comparator output will change state, thus producing a square wave of equal frequency.

555 BLUES

I'm having 555 frustrations in putting together what
(Continued on page 89)

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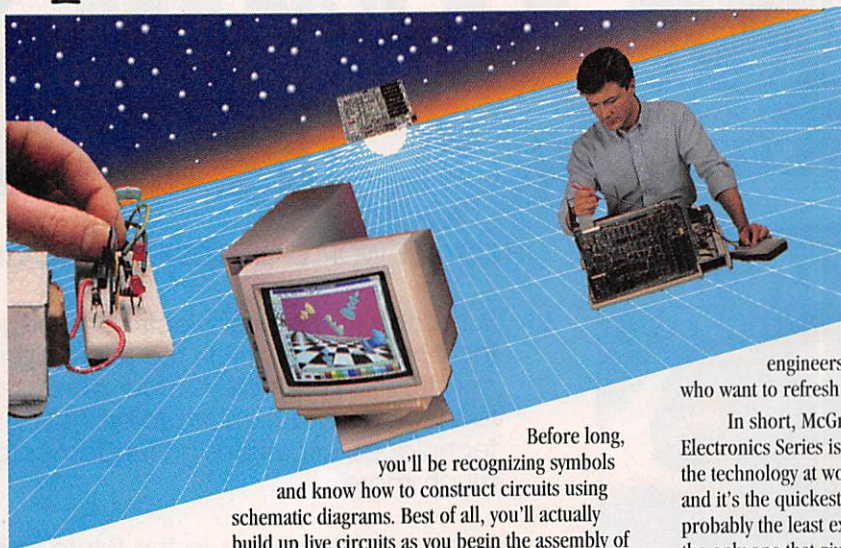
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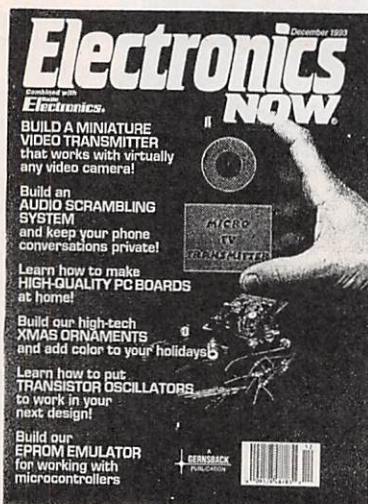
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Over one hundred years ago, Alexander Graham Bell referred to the infant telephone network as "this grand system." If it seemed like a complex system to him at the time, he would be amazed at how it has developed. It's important to remember the telephone's humble beginnings when trying to understand our modern telecommunications network.

Our phone system is the way it is today because it was based on the technology of 1878 and has evolved from there. Each innovation had to be compatible with the existing system, so many of the limitations of the original technology are still with us today. The modern version of Bell's dream has become a kludged system where technologies that were appropriate for wire, bells, and hand-crank magnetos are mixed with high-speed, electronic-switching systems, geosynchronous communications satellites, and fiber optics.

However, it's difficult to argue with success—the technological mishmash has served us well. The new technologies have added a lot of nice features, most of which are available from your local telephone company for an additional monthly fee. One of those features is a distinctive ring signal that allows you to assign an alternate number to your telephone line. Your original number continues to ring the way it always did, but any call to the new number causes your phone to ring with a distinctly different ring pattern.

Such features are commonly used by roommates who are tired of answering each other's calls. With distinctive rings, they each have a separate telephone number, and the sound of the ring indicates who the call is for before the phone is answered. Much more sophisticated uses for distinctive ringing are possible if a smart device can automatically

Build This



Distinctive Ring Switch

Route incoming telephone calls to the appropriate device with this automatic call-directing circuit

BY BRUCE LAYNE

analyze the ring pattern and switch the phone line.

For example, I recently started a second home-based business. Together, both businesses account for considerably less telephone traffic than the average family with an active teenager, so the cost of a separate phone line was difficult to justify. I requested the distinctive ring service from my local telephone company and had my long-distance carrier assign my new 800-number service to the distinctive-ring number. The only problem was when the answering machine was involved, it would answer either ring, but always played the message as though it was from my original number.

With the *Distinctive Ring Switch* described in this article, the situation has changed—I can now have a second answering machine take all calls for the new company. Adding a fax ma-

chine or a computer BBS to an existing telephone would be a more common use for the Distinctive Ring Switch.

Circuit Description. A schematic diagram of the Distinctive Ring Switch is shown Fig. 1. At the heart of the circuit is a PIC16C54 microcontroller, which packs a lot of power into its tiny 18-pin DIP package. The PIC contains an 8-bit, real-time clock counter (RTCC) that is software configured to increment every 256 internal clock cycles. The internal clock is derived by dividing the oscillator clock by four. A preprogrammed PIC is available from the source given in the Parts List. For those that have the knowledge and ability to do their own programming, the source and object code is also available via the mail or it can be downloaded from this magazine's BBS (516-293-2283).

The PIC's oscillator can be crystal controlled, but our application doesn't warrant such accuracy. Instead, a couple of bits in-

side the PIC are programmed to use a resistor/capacitor (RC) network as the oscillator. That RC combination (R7 and C1 connected to pin 16) sets the oscillator's frequency to 47 kHz. (PIC's are capable of operating at 20 MHz). That frequency was chosen to enable the RTCC to time all events of interest without overflowing.

Twelve of the PIC's eighteen pins can be software configured as either inputs or outputs. As outputs, those pins can each source 20 mA of current, which is more than sufficient to directly drive the LED's attached to pins 7 and 8. The LED's are used to indicate which device is connected to the incoming phone line. The output pins also provide adequate current to directly drive the relay (K1) connected to pin 9, which switches the devices to the incoming phone line.

To know when to properly switch the

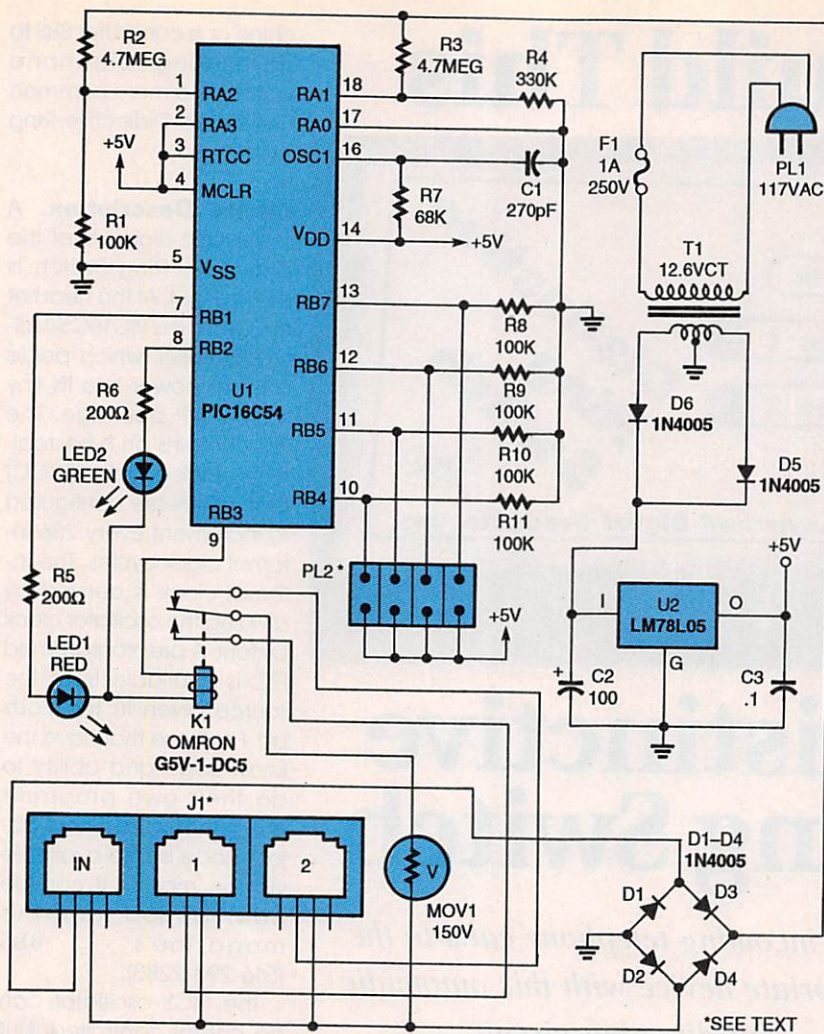


Fig. 1. At the heart of the Distinctive Ring Switch is a PIC16C54 microcontroller (U1), which contains an 8-bit, real-time clock counter (RTCC) that is software configured to increment every 256 internal clock cycles.

devices, the PIC needs to monitor the phone lines for two types of events. It needs to know when the phone is ringing and it needs to know whether the phone is answered or hung up. Technically, when the phone is answered, the condition is called "off hook" and when it is hung up it is called "on hook." Ring status and hook status each use one input pin on the PIC, pins 1 and 18, respectively.

Outwardly, each of those pins seems to be merely connected to a voltage divider, but the important part of the circuit is buried inside the PIC. The input pins have clamping diodes to prevent excessive voltages from damaging the microcontroller. The PIC's clamping diodes are particularly robust, enabling it to be used to clamp the high voltages present on the phone lines. The 4.7-megohm resistors leading to pins 1

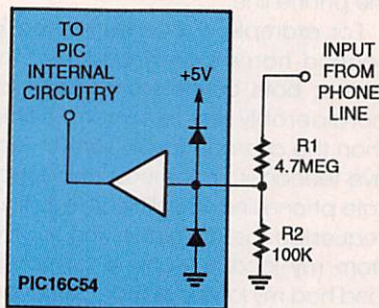


Fig. 2. The ring-detect circuit (which consists of a pair of external resistors, and an internal Schmitt trigger and a pair of diodes) conditions the analog signals from the phone line to produce digital 1's and 0's.

and 18 are used to limit the current to very low levels. They also form the upper legs of voltage dividers that produce signals to indicate the hook and ring status.

Figure 2 shows the ring-detect circuit, including the components that are inside the PIC. The ring and hook status signals are actually very poorly conditioned when they are presented to the microcontroller, but the PIC's internal clamping diodes restrict the signals to within one diode drop (about 0.6 volts) of the power-supply voltage limits. The PIC also has a Schmitt trigger on each input, that further conditions the analog signals from the phone line into a digital highs and lows.

During thunder storms, very high voltages can be induced on the phone lines by nearby lightning strikes. Because of that a 150-volt, metal-oxide varistor (MOV1) is used on the incoming phone line to prevent voltage spikes from damaging the Distinctive Ring Switch. As an added bonus, the connected devices also benefit from that lightning protection.

Basic Telephone Theory. The phone line is really just two wires, called *tip* and *ring*. The origin of both terms dates back to the earliest days of the telephone when operators manually connected calls by plugging a cable into a jack on a panel. One of the wires in the cable connected to the tip of the cable's plug, and the other connected to the ring around the outside of the plug.

Most phones will operate properly even if the tip and ring lines are swapped, although some older phones may not ring properly. Note, however, that the Distinctive Ring Switch requires proper tip and ring wiring, a bridge rectifier in that circuit (diodes D1-D4 in Fig. 1) routes the signals as needed to assure the correct polarity.

The pair of wires that extends from your house is called the local loop, which terminates at the central office. The central office connects - 48 volts DC to your ring line and connects the tip line to ground. A series resistance of 350 to 800 ohms is included to limit the short-circuit current to safe levels. There will also be as much as 1900 ohms on the line due to the resistance of the local loop. The farther you are from the central office, the higher the resistance in the local loop.

When your phone is off hook, its internal resistance is connected across the phone line, allowing current to flow. Most telephones have an inter-

PARTS LIST FOR THE DISTINCTIVE RING SWITCH

SEMICONDUCTORS

U1—PIC176C54-RC/P
microcontroller, integrated circuit
U2—LM78L05 5-volt, 100-mA,
voltage regulator, integrated circuit
D1-D6—1N4005 1-amp, 600-PIV,
silicon rectifier diode
MOV1—150-volt metal-oxide varistor
LED1—Red light-emitting diode
(T-1-3/4)
LED1—Green light-emitting diode
(T-1-3/4)

RESISTORS

(All fixed resistors are 1/4-watt, 5% units.)

R1, R8-R11—100,000-ohm
R2, R3—4.7-megohm
R4—330,000-ohm
R5, R6—200-ohm
R7—68,000-ohm

CAPACITORS

C1—270-pF, ceramic-disc
C2—100- μ F, radial-lead electrolytic
C3—0.1- μ F, ceramic-disc

ADDITIONAL PARTS AND

MATERIALS

F1—1-amp, 250-volt fuse
T1—12.6-volt, center-tapped (Mouser #41PG006, or similar) transformer
PL1—Molded AC power plug with line cord
PL2—4-position PC-mounted, dual header (with shorting jumpers)
K1—Omron G5V-1-DC5 SPDT (Digi-Key #Z773-ND or similar) 5-volt relay
Printed-circuit materials, enclosure, rubber feet, fuse clips, LED-mounting clips, rubber grommet, 18-pin DIP socket, wire, solder, hardware, etc.

Note: The following items are available from Advanced Digital Products, Inc. (300 Bent Bough Place, Lexington, KY 40509-1403; Tel. 606-268-6005); a preprogrammed PIC16C54 microcontroller for \$9.00; printed-circuit board, \$9.00; custom enclosure, \$12.00; complete kit of parts, \$43.00. Please add \$3.50 to all orders for shipping and handling. Kentucky residents, please add appropriate sales tax. Send self-addressed stamped envelope for PIC source and object-code listing. Send SASE and blank 3.5- or 5.25-inch floppy disk for the source and object code on a PC-compatible disk. Code requests do not require shipping and handling charges.

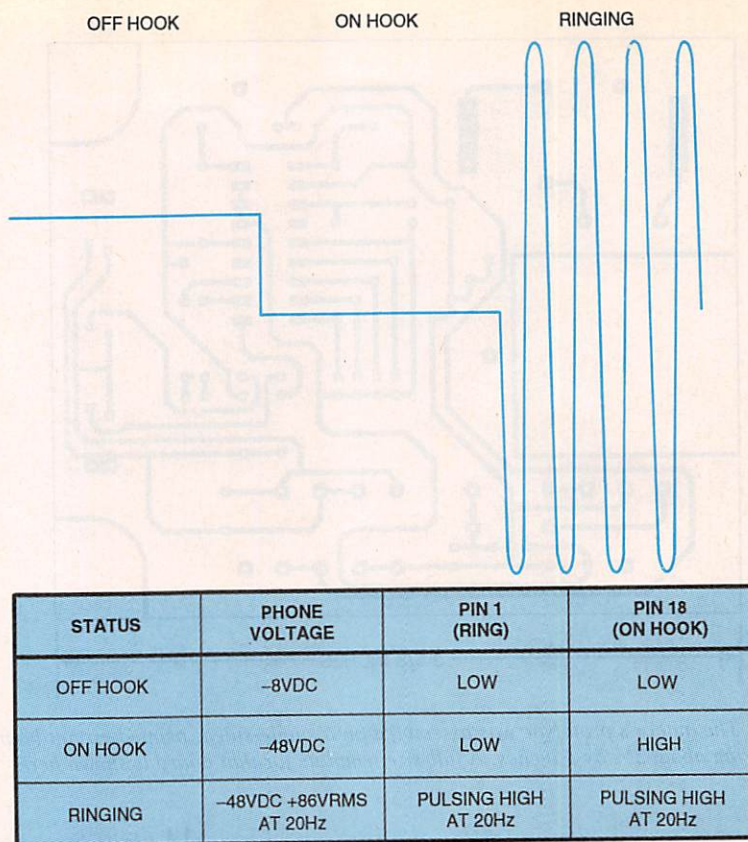


Fig. 3. Shown here are some typical telephone-line voltages and their corresponding microcontroller input signals. When someone calls, the phone company superimposes a 86-volt, 20-Hz ring signal onto the -48 volts DC already present on the line.

nal resistance of 100 to 400 ohms. The current varies according to the resistance at the central office, the resistance of the local loop, and the resistance of any phones that are off hook. Multiple off-hook phones are in parallel, so each additional phone that goes off hook increases current flow in the local loop. The central office senses the current flow, provides a dial tone and prepares to receive the number that you dial. The off-hook current is usually 6 to 25 mA. Figure 3 shows some typical telephone line voltages and their corresponding microcontroller input signals.

When someone calls you, the phone company superimposes a 86-volt, 20-Hz ring signal on top the -48 volts DC already present. The ring patterns vary between different locations. The normal ring pattern for the United States is two seconds on and four seconds off. Some parts of the U.S. and Europe have a normal ring of one second on and three seconds off. My distinctive ring is 0.8 seconds on, 0.4 seconds off, 0.8 seconds on and 4 seconds off, however, ring patterns can vary greatly.

Construction. Almost any construction technique (printed-circuit board, wire wrap, or point-to-point solder connections) will work for the Distinctive Ring Switch. However the author's prototype was assembled on a the single-sided, printed-circuit board, measuring about 3 1/2 by 3 inches. Figure 4 shows a full-size printed-circuit template of that layout.

Note the two curved cutouts for the enclosure mounting screws, as well as the rectangular cutout for the transformer. The transformer should be mounted 1/4-inch below the printed-circuit board to accommodate the top of the enclosure. A component-placement diagram is shown in Fig. 5.

With so few components, assembly is quite simple. However, the usual warnings apply concerning the polarity of the diodes, LED's, IC's, and the electrolytic capacitor. Solder all the components to the board, using a socket for the 18-pin microcontroller. Before installing the microcontroller or applying power, use the resistance or continuity setting of a multimeter to verify that the power-supply ground on the middle pin of U2 is connected

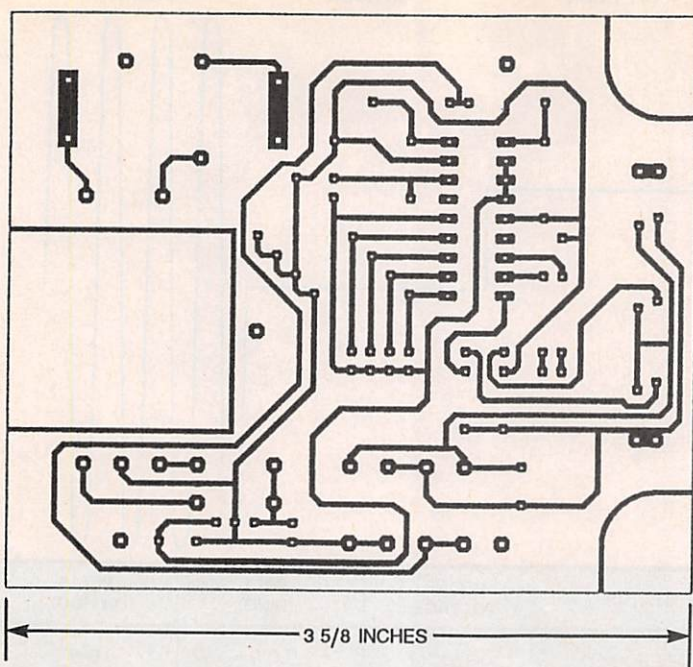


Fig. 4. The author's prototype was assembled on a single-sided, printed-circuit board, measuring about $3\frac{5}{8}$ by 3 inches. A full-size template for that board is shown here.

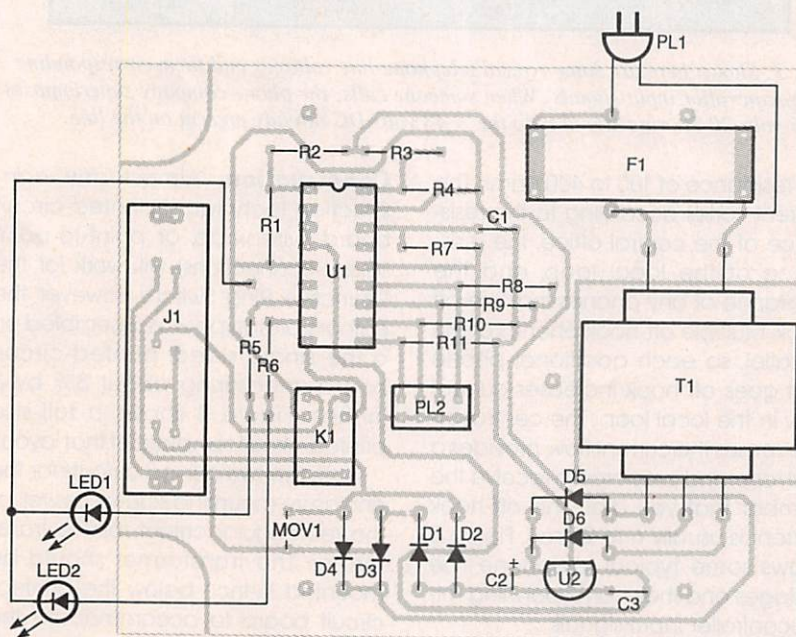


Fig. 5. As shown by this parts-placement diagram, there are very few components in the circuit. When assembling the circuit, however, pay attention to the orientation of the polarized components (diodes, LED's, IC's, and the electrolytic capacitor).

to pin 5 of U1's socket. Using the same technique, check for a good ground every place it appears in the circuit. Also verify that the ground is not shorted to the +5-volt supply line.

If the ground checks out, disconnect the multimeter and plug in the power cord. Select the voltage setting on your multimeter and verify that +5 volts is present at pins 2, 3, 4, and 14 of

U1's socket, as well as on all four of the header pins not directly connected to the microcontroller. If the power supply checks out, unplug the power cord and install the microcontroller into its socket. You should now be ready to attach the incoming phone line, plug in a couple of telephone devices and test the Distinctive Ring Switch.

REFERENCES

Understanding Telephone Electronics
John L. Fike

The Art of Electronics, 2nd Edition
Paul Horowitz and Winfield Hill (p. 935)

PIC16C5x Microcontroller Application Notes (Set two, p. 270)

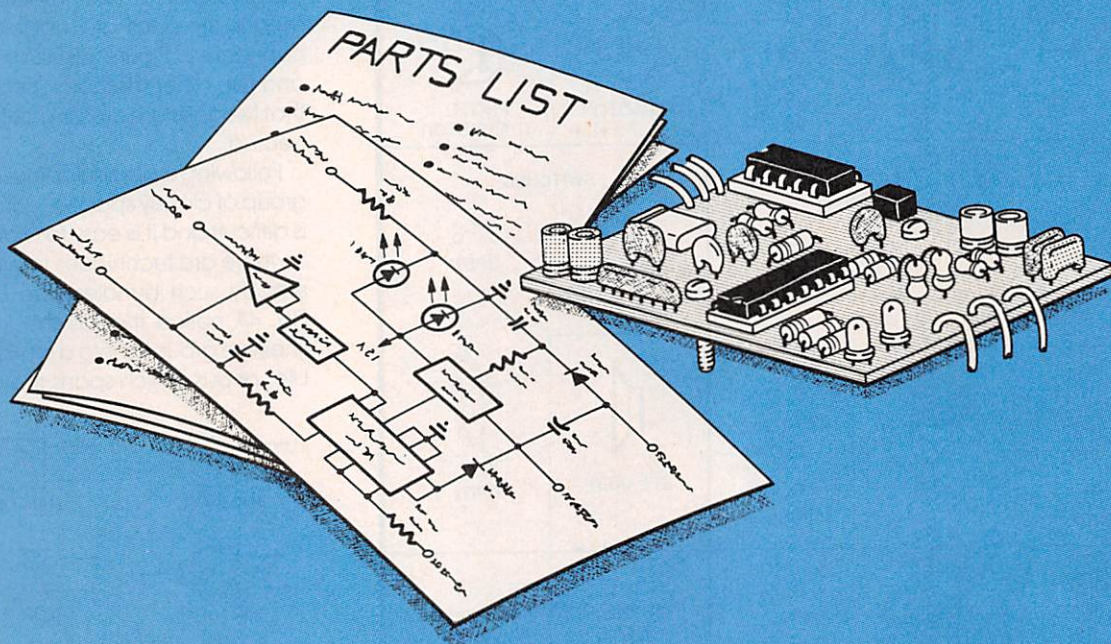
If you experience any trouble, a good way to check for some sign of life from the microcontroller is to disconnect the incoming phone line and attach an oscilloscope or frequency counter to pin 15 of U1. You should find a good square wave with a frequency of about 11,750 Hz, which is the clock oscillator divided by four. You should always disconnect the incoming phone line before attaching your oscilloscope leads. The ground lead on most AC-powered oscilloscopes is attached to an earth ground via the oscilloscope's power cord. The Distinctive Ring Switch routes the -48-volt ring signal to its ground, so the tip line appears to be +48 volts, making it easier to detect ring and hook status. Connecting a grounded scope lead to the -48-volt circuit ground will ground the ring line and the central office will detect current flowing.

Setup. The Distinctive Ring Switch has four jumpers, one for each of four ring patterns. Each jumper has two positions, one for each device. That allows a great deal of flexibility for unconventional switching functions, as well as accommodating phone systems other than those in the United States. For example, the normal ring cycle for phones in the U.K. consists of 0.4 seconds on, 0.2 seconds off, 0.4 seconds on, and 2 seconds off. The timing is slightly different from my distinctive ring, but it is close enough.

The Distinctive Ring Switch would still count two rings per ring cycle, just like my distinctive ring. The jumpers prevent that problem by allowing you to select either device 1 or device 2 for each of four different ring patterns. When the leftmost jumper is closed, one ring per ring cycle will connect the incoming line to device 1. When open, one ring per ring cycle will connect the incoming line to device 2.

(Continued on page 92)

DOCUMENTATION



Complete files on projects can save you from hours of head scratching during repairs, and yet most hobbyists are much neater with solder than paper work. We present some hints on how to get your notes in order.

BY JACK CUNKELMAN

When you're caught in the rush to enjoy a newly completed project, its documentation usually falls by the wayside. That's fine until you have to repair the project or want to share it with someone else. Thoughts that were clear at one time are suddenly fuzzy. In the mind, details of changes and fixes made during construction become intermixed with those of other projects.

Working in an environment in which several people were responsible for the maintenance of custom-designed equipment forced me into the habit of documenting everything (well almost everything) I did. I became as proud of the documentation as I was of each project and the information was a lifesaver when a repair was necessary. That discipline spilled over to my home projects and has proved just as helpful.

In this article, I would like to inspire

you to cultivate the same habits. Since a schematic is the road map of any electronic project, what will follow are some tips on how to generate a schematic in a standard, orderly format. Then we will discuss the parts list, layout diagram, and block diagram. The tips that I will be offering are some of the techniques I use in my documentation efforts. For a more detailed look at this subject one of my favorite books is *Electronic Drafting and Design*, by Nicholas M. Raskhodoff, published by Prentice-Hall. With all that in mind, let's proceed.

Notes. Keeping good notes as a project progresses is essential. For that, a notebook, or at least a file folder, about each project is useful. Always write down any changes as you make them, while they are fresh in your mind.

If I am working on a design of my own, I make the notes about compo-

nent changes and design alterations on a working schematic. I later redraw the schematic using all the added information.

On projects from magazines, I usually like to photocopy the schematic, parts layout, and parts list, and then take the copies with me to the workbench. I note any part additions, deletions, and value changes that I make on the copies. Magazine projects that are built without modification need only the material from the magazine article included in its documentation package.

I also take a set of typical voltage and resistance readings at critical points in the working circuit and add them to the notes, and later to the final schematic. That information usually proves invaluable during repair sessions. Oscilloscope-waveform observations at these same critical points may also be appropriate. Sketches of the waveforms indicating

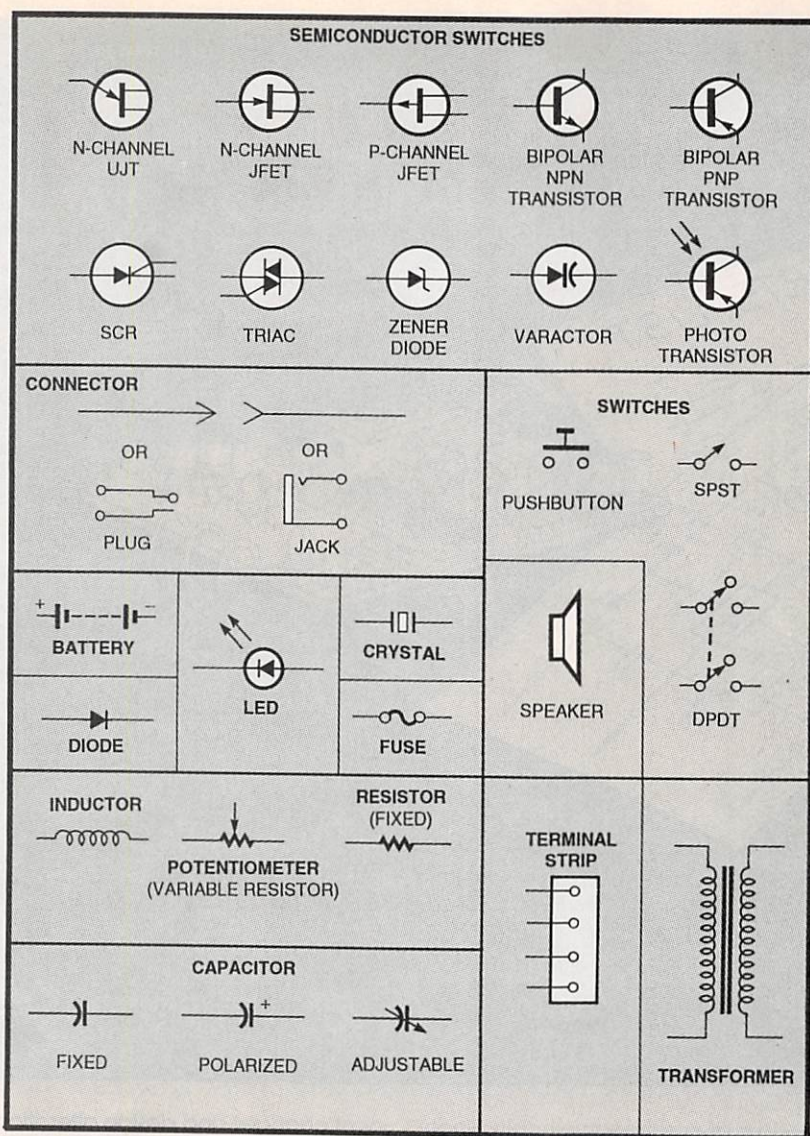


Fig. 1. Here are some of the most commonly used symbols for parts in schematics. You've probably seen all of them in this magazine at one time or other.

the peak voltage values should also be included in the notes.

Symbols and Lines. A schematic diagram is the single most important piece of information about any electronic assembly. Using a set of standard graphic symbols to represent each individual component, the schematic shows how the components are interconnected. Thumbing through this magazine should reveal many example schematics. Some of the more common component symbols are shown in Fig. 1.

Integrated circuits in schematics are represented by blocks or function symbols. A function symbol graphically indicates the function an IC performs, while a block, which is used to represent more complicated logic

functions, specifies only pinouts. Figure 2 shows some commonly used symbols and a block. Next to each pin on the inside of the block is its function label. The number of each pin appears just outside the block. Pin numbers should also be assigned to the function symbols when drawing your own schematics.

Blocks can also be used to represent repeated elements in a drawing. If a stage or section that contains many elements is repeated many times in a schematic, it is acceptable to draw the stage only once and then represent the stage later as a block with only its external connections labeled. Using blocks helps eliminate redundant details.

The symbolic components and blocks in a schematic are intercon-

nected with lines. When two lines cross and should be electrically connected, a dot is placed at their intersection to indicate the electrical junction. Two examples of that are shown in Fig. 3A. When two lines cross with no dot at the intersection, it means the lines are not electrically connected. Figure 3B illustrates that and two other methods used to show that two lines are crossing but not connected.

Following a particular line in a large group of closely spaced, parallel lines is difficult and it is easy to make errors. So there are techniques to group and simplify such bundles (see Fig. 4). In Fig. 4A notice that all the individual lines are grouped into a symbolic "cable" or bus, which spans the drawing.

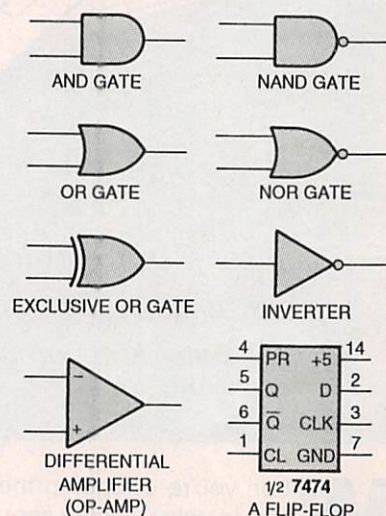


Fig. 2. Logic devices are often represented by a gate symbol or a block. A gate symbol reveals the operation performed by a gate to aid functional comprehension of a schematic.

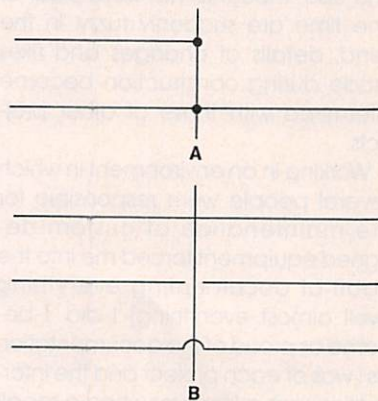


Fig. 3. Dots are used to indicate an electrical connection when two wire cross (A). If there's no dot, or if there's a gap or a hoop (B), it means the wires are not connected.

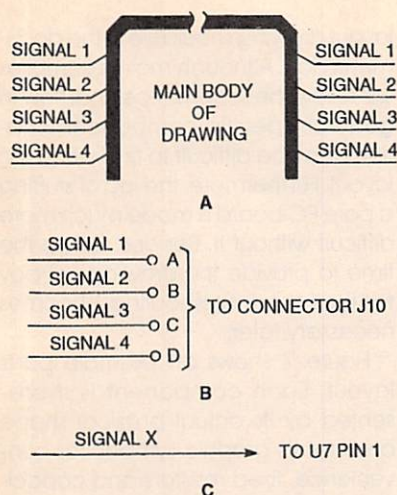


Fig. 4. Multiple wires crossing an entire schematic can look messy. However, they can be bundled in a bus (A), or grouped with a bracket declaring their destination (B). Single wires that have a way to go can make use of an arrow instead (C).

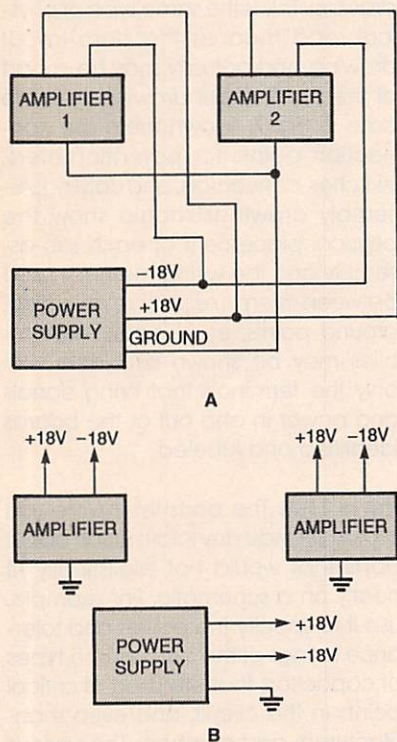


Fig. 5. Wiring power to every point in a circuit can get messy (A). A better method is to use arrows (as presented back in Fig. 4) and ground symbols (B) to avoid routing traces all over.

For clarity, a unique, descriptive label is attached to each line before it enters the bus, and again when it leaves. Multiple lines that run from one side of the drawing to the other can also be interrupted, bracketed, and labeled as shown in Fig. 4B. A method of interrupting a single line that would other-

wise have to be drawn across the whole drawing is shown in Fig. 4C.

Schematic Layout. The schematic as a whole should be clear and understandable. To that end, a little thought on how the symbols will be arranged on paper is worthwhile. The component symbols should be grouped into stages with all the components of a particular stage grouped around the main component of that stage. The main component in a stage may be a transistor, op-amp, digital IC, or whatever. Where possible, main-component symbols should be arranged with input(s) on the left and output(s) on the right (so key signals will flow from left to right).

You should consider breaking complex projects into smaller schematics to aid clarity. The power-supply section is a good place to start. Drawing it in an unused corner of a drawing, or even on a separate piece of paper, will make the main portion of the schematic more comprehensible.

How you route the power-supply lines is also important. Two power-distribution methods for a circuit are shown in Fig. 5. (Note that the power-supply and amplifier stages are represented by blocks.) In Fig. 5A, an interconnect line is drawn between each power-supply terminal and each op-amp block. That method should be avoided in all but the simplest of schematics. Note that the same information is presented in Fig. 5B but the diagram is more readable.

A couple of ground symbols snuck

TABLE 1—POPULAR DESIGNATORS

ITEM	DESIGNATOR
BATTERY	B
CAPACITOR	C
PLUG	P
JACK	J
CRYSTAL	XTAL
DIODE	D
FUSE	F
INDUCTOR	L
INTEGRATED CIRCUIT	U
LIGHT-EMITTING DIODE	LED
METER	M
POTENTIOMETER	R
RELAY	K
RESISTOR	R
SPEAKER	SPKR
SWITCH	S
TRANSFORMER	T
TRANSISTOR	Q
TUBE	V

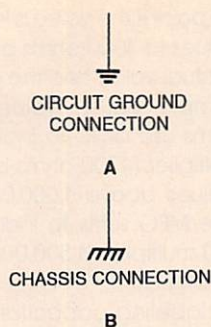


Fig. 6. The most typical ground symbol (A) is the power-supply ground. There is also a chassis-ground symbol (B), which denotes a point in a circuit that should be connected to a cabinet.

into Fig. 5, so let's discuss them now. The ground bus is often portrayed as line that snakes thru the drawing. Figure 5A is an example of a drawing that uses a continuous line to connect each ground point. In a simple schematic that may be okay, but in larger schematics with many ground points, that would be difficult to follow. So a ground symbol is used at each ground-connection point, as shown in Fig. 5B.

The signal-ground and chassis-ground symbols shown in Figs. 6A and 6B, respectively, actually tell the reader how to route the ground wiring. They show two distinct types of grounds, so they are not interchangeable. A signal ground is usually connected to ground at only one point, the power supply. The chassis symbol tells the reader at which point a circuit connects to the chassis.

Component Identification.

Identifying parts with designations (R1, C2, etc.) and values (10Ω, 0.1-μF, etc.) is the next most important step in drawing a schematic. Attaching a designation to each part allows them to be individually keyed to descriptions in parts lists and any accompanying text. Table 1 lists some standard designation prefixes for components you are most likely to use in your schematics. The numbering for the designations should run from left to right and top to bottom on the schematic. Locate each designation as close to its part as possible. Note that vertical lettering should be avoided.

You should place the value of each component directly below its reference designation. When labeling resistor values, add a 0 to the left of the

decimal point if the value is less than 1 ohm. Values to 1000 ohms are shown as the actual value and the ohm sign (for example, 820Ω). Values above 1000 ohms use a "k" to indicate the 1000 multiplier (4700 ohms is labeled 4.7k). Values above 1,000,000 ohms need the MEG suffix to indicate the 1,000,000 multiplier (1,500,000 ohms is written 1.5MEG).

When labeling capacitors, values to 999 pF are shown in pF. Values above that are given in microfarads or μF s (1,000,000 pF = 1 μF). Often times the micro symbol is dropped as it is simply understood, so a 1- μF capacitor is labeled just "1."

A note can be added to the drawing to show any extra labeling con-

ventions you are using. For example: "Unless otherwise specified: 1) Resistance values are in ohms or kilohms (abbreviated K); 2) Capacitance values are in microfarads."

Besides labeling component values, be sure to label all the switch terminals, terminal-block positions, and connector pins on the schematic. All terminations and connections to the outside world should be shown at the outer edges of the drawing.

Component Layout Drawing. Since the schematic drawing does not show the physical placement of components on the completed circuit board or assembly, a component-

layout drawing should be in the documentation. Although most assemblies will follow the schematic signal flow in general, specific component locations may be difficult to find without a layout. Furthermore, the job of stuffing a bare PC board is made much more difficult without it. Besides, taking the time to provide this drawing will pay for itself if troubleshooting becomes necessary later.

Figure 7 shows an example parts layout. Each component is represented by its actual physical shape and not its graphic symbol; for convenience, fixed resistors and capacitors can be shown as straight lines. The components are labeled with just their reference designations (not their electrical values) to reduce clutter.

A completed assembly that has several circuit boards and/or multiple connectors may need an assembly drawing. This is the same type of physical road map as the parts-layout drawing and actually may be a part of the parts layout drawing as is the case in Fig. 7. Shown there are connection points for potentiometers, switches, connectors, and cabling. Assembly drawings should show the physical placement of each sub-assembly and the wiring methods used between them (*i.e.*, cable shielding, ground points, etc.). The sub-assemblies may be shown as blocks with only the terminals that bring signals and power in and out of the boards identified and labeled.

Parts List. The parts list is where you should provide any information about parts that would not realistically fit neatly on a schematic. For example, use it to specify the power and tolerance ratings of the resistors, the types of capacitors that are used at critical points in the circuit, and even manufacturer's part numbers. The various kinds of components (*i.e.*, resistors, capacitors, etc.) should be grouped together and arranged in numerical order. Check out the parts lists in this issue to gain a feel for what they cover.

Block Diagrams. If your design is particularly complicated, a block diagram should be included in your documentation. A block diagram uses blocks as presented earlier to

(Continued on page 94)

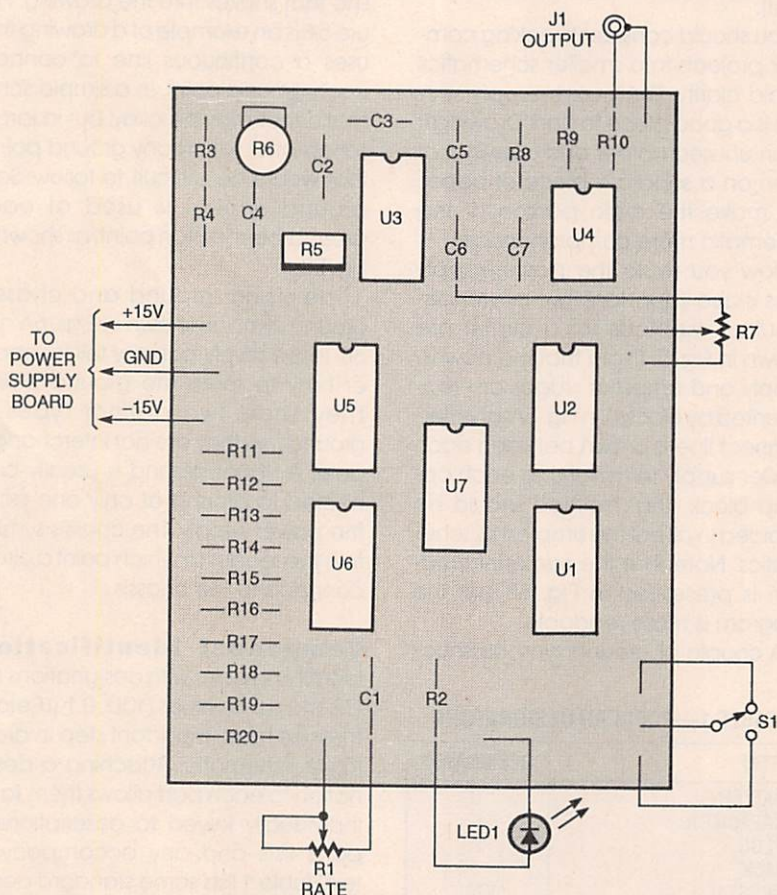


Fig. 7. When preparing a parts layout, it is just as important to indicate all off-board connections as it is to include all on-board parts.

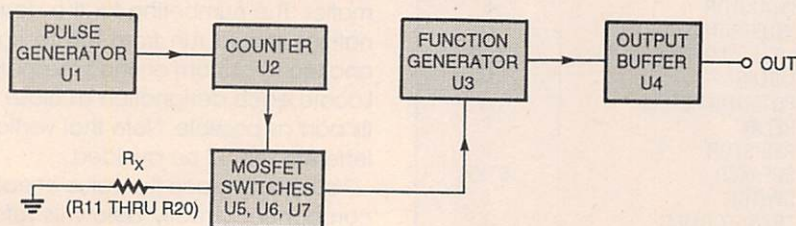


Fig. 8. Block diagrams can help you make instant sense of even the most complex devices.

Since the introduction of low-cost model rocket engines in the 1950's, building and launching small-scale rockets have been popular pastimes. While designing and finishing high-performance models is both interesting and challenging, it is also fun to design and build electronic gadgets to go along with them. One such gadget is the *Time-Delayed Launch Control* described in this article.

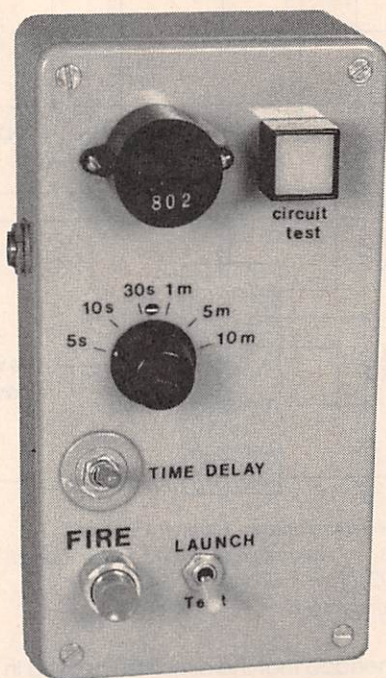
With the Time-Delayed Launch Control, you press the fire switch to initiate a launch sequence, then the circuit begins its countdown, giving you plenty of time to step back so that you can view the impending event from a safe distance, record the launch, or prepare to monitor experiments during the flight. At the end of a preset period, the circuit ignites the rocket's engine, sending it skyward.

The circuit has six preset delay intervals: 5, 10, and 30 seconds, and 1, 5, and 10 minutes. The circuit also contains a piezoelectric buzzer that beeps every few seconds as the system counts down to launch. As a safety feature, a launch sequence can be aborted at any time, simply by shutting the system off or by switching to the test mode. The main function of the test mode, however, is to verify, via a front-panel indicator, that the ignition circuit is properly wired. The circuit is powered from its own internal battery pack, which also provides power to the rocket-engine igniter.

Circuit Description. A schematic diagram of the Time-Delayed Launch Control is shown in Fig. 1. The circuit—which gives a choice of 6 delay settings—is comprised of three 555 oscillator/timers (U1–U3), a pair of transistors (Q1 and Q2), four switches (S1–S4), a piezoelectric buzzer (BZ1), and a few support components. Power for both the control circuit and the rocket-engine igniter is provided by a 6-volt power source that is comprised of 4 AA-cell alkaline batteries. Alkaline batteries are specified because other types are incapable of supplying the 1–3 amps required to fire a rocket-engine igniter. Closing switch S1 feeds power to the launch-control circuit, but does not initiate a launch sequence.

A pair of series RC circuits (R4/C9

A Time-Delayed Model-Rocket Launch Control



Add a touch of class and safety with this deluxe model-rocket launch-control circuit

BY DAN BECKER

and R8/C12, respectively) are used to debounce the reset inputs (pins 4) of U1 and U2 (a pair of 555 oscillator/timer IC's), thereby preventing false triggering from occurring during power up or when switching modes. Pull-up resistors R1 and R2 effectively shunt capacitor C1, keeping it discharged until S2 (FIRE) is momentarily closed. When S2 is closed, C1's negative terminal is connected to ground through the switch, momentarily pulling pin 2 of U1 (which is configured as a monostable multivibrator, or one shot) low, activating it.

Once triggered, U1's output goes high for an interval that's determined by R3 and one of six timing capacitors

(C2 through C8). The timing capacitor is selected via DELAY SELECTOR switch S3. Positions 1 through 6 of S3 give intervals of 5, 10, or 30 seconds or 1, 5, or 10, minutes, respectively.

The high output of U1 at pin 3 is fed through current-limiting resistor R12 to the base of Q2, forward biasing it, which causes Q2 to turn on, allowing the piezoelectric buzzer, BZ1, to turn on when the proper signal is applied to BZ1's negative terminal. Monostable U1's output is also fed to the reset input of U3 (which is configured as an astable multivibrator or oscillator) at pin 4, causing it to oscillate with a duty cycle of about 75% (as determined by C14, R10, and R11). As long as the output of U1 is high and the astable is oscillating, BZ1 beeps once every 4 seconds.

Resistor R5 discharges coupling capacitor C10 whenever U1's output goes high, while R6 maintains the normally high bias voltage required at U2's trigger input (pin 2). At the end of the selected time delay, U1's output goes low. That low is coupled through C10 and D1 to the trigger input (pin 2) of U2, which (like U1) is configured as a monostable multivibrator.

Components R7 and C11 set U2's high-output interval to approximately 3 seconds. During that 3-second interval, U2's high output at pin 3 is fed to Darlington transistor Q1 through R9 (which limits base-bias current to the device to less than 40 mA). With S4 in the LAUNCH position, Q1 grounds one end of the engine igniter, effectively connecting it to the battery's negative terminal. During that 3-second interval, approximately 1–3 amps passes through the engine igniter, causing it to glow and burn.

Construction. To assemble the launch-control circuit, you'll need all of the components listed in the Parts List. You'll probably want to customize the project, so pick out switches, a lamp, and a piezoelectric buzzer that will give your launch control an interesting and personalized appearance.

Start with the enclosure. The enclosure must be large enough to accommodate the printed-circuit board and all of the front-panel controls, and still leave room for the quad AA-cell battery pack. The overall di-

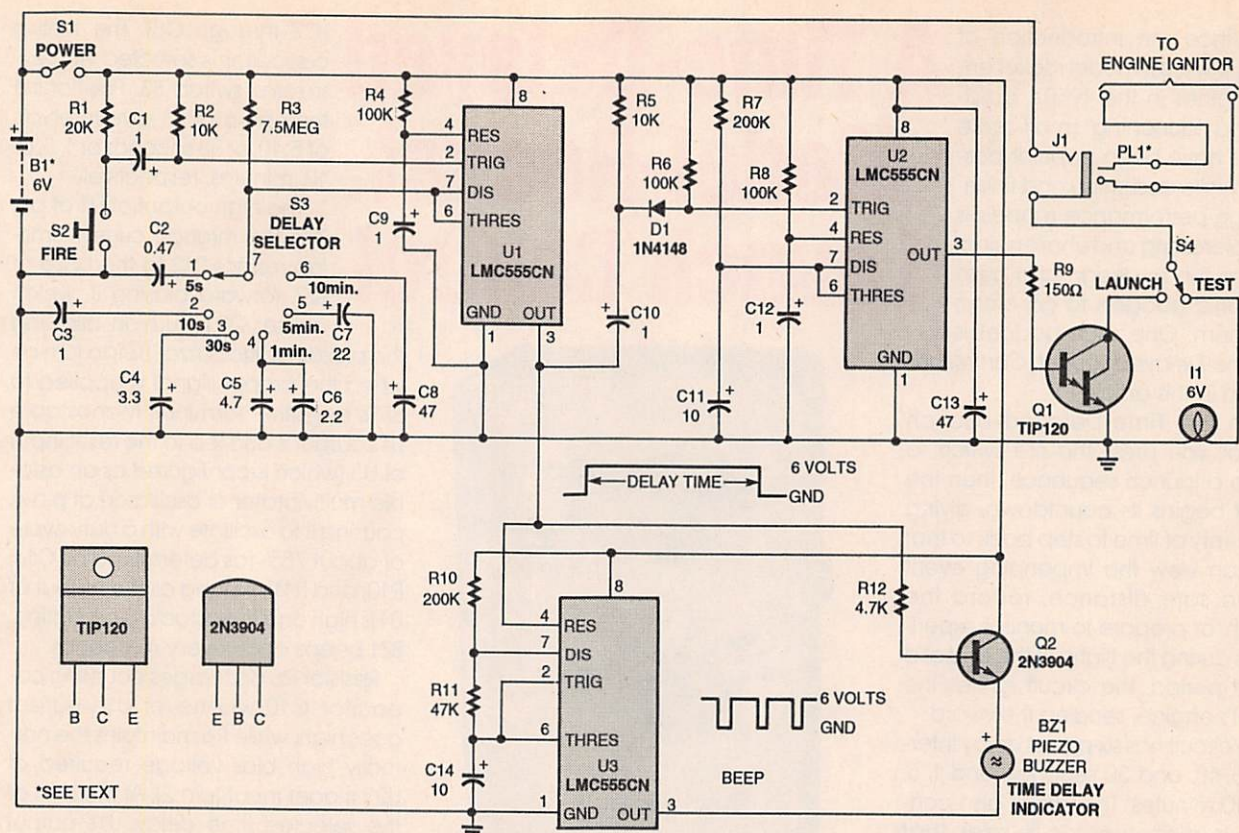


Fig. 1. As shown by this schematic diagram, the Time-Delayed Launch Control circuit—which gives a choice of 6 delay settings—is comprised of three 555 oscillator/timers (U1–U3), a pair of transistors (Q1 and Q2), four switches (S1–S4), a piezoelectric buzzer (BZ1), and a few support components.

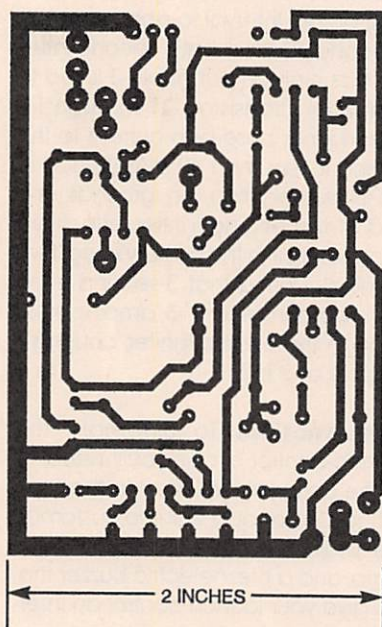


Fig. 2. The author's prototype was assembled on a printed-circuit board, measuring about 2 by 2¹³/₁₆ inches. Here is a full-size template of that printed-circuit layout.

mended that the circuit be housed in an brightly-colored ABS plastic enclosure. A plastic enclosure is recommended because you'll have to drill about ten holes in it, and ABS plastic is much easier to work with than steel or aluminum.

Choose a convenient location on the front panel for the test lamp (I1), the piezoelectric buzzer (BZ1), and the four switches (S1–S4). Mark and drill the mounting holes for those components. Then drill a hole in the side of the enclosure for phono jack J1. It should be located about 2 inches from the end of the enclosure where the battery pack will go. Clean any burrs from the holes and check all front-panel components for a proper fit; but do not mount them yet.

If you are unable to find a brightly colored enclosure, you can spray paint the one you choose after all the mounting holes have been drilled and deburred. If you must paint the enclosure, apply 2 or 3 thin coats of primer (or white), followed by 2 thin coats of a bright-colored paint. Give each coat a couple of hours to dry

before applying the next coat, then let it set overnight.

With that done, use dry-transfer (rub-on) lettering to label each switch position according to its function—the rotary switch with its delay times should be marked at each stop—and the test lamp.

After labelling, protect the dry-transfer lettering by applying one or two coats of clear lacquer. Allow all coats to dry several hours. The front panel is now ready for assembly. Mount BZ1, I1, and S1–S4, and J1 to the enclosure, and don't forget to install a knob on the shaft of S3.

Since the control circuit contains only three IC's and two transistors, you can easily assemble it on a small piece of perfboard using wire-wrap or point-to-point wiring techniques. However, the author's prototype was assembled on a printed-circuit board that measures about 2 by 2¹³/₁₆ inches. A full-size template of that printed-circuit layout is shown in Fig. 2. Once you've etched the board, drill all holes with a No. 67 bit. That bit size will accommodate all of the component

PARTS LIST FOR THE TIME-DELAYED LAUNCH CONTROL

SEMICONDUCTORS

U1-U3—LMC555CM CMOS
oscillator/timer, integrated circuit
Q1—TIP120, SK3180 (or similar)
NPN Darlington transistor
Q2—2N3904 general-purpose NPN
silicon transistor
D1—1N4148 general-purpose silicon
diode

RESISTORS

(All fixed resistors are 1/4-watt, 5%
carbon-film units.)

R1—20,000-ohm
R2, R5—10,000-ohm
R3—7.5-megohm
R4, R6, R8—100,000-ohm
R7, R10—200,000-ohm
R9—150-ohm
R11—47,000-ohm
R12—4,700-ohm

CAPACITORS

C1, C3, C9, C10, C12—1- μ F, 16-
WVDC, radial-lead electrolytic
C2—0.47- μ F, 16-WVDC, radial-lead
electrolytic
C4—3.3- μ F, 16-WVDC, radial-lead
electrolytic
C5—4.7- μ F, 16-WVDC, radial-lead
electrolytic
C6—2.2- μ F, 16-WVDC, radial-lead
electrolytic
C7—22- μ F, 16-WVDC, radial-lead
electrolytic
C8, C13—47- μ F, 16-WVDC, radial-
lead electrolytic
C11, C14—10- μ F, 16-WVDC, radial-
lead electrolytic

ADDITIONAL PARTS AND MATERIALS

B1—See text
S1—SPST toggle switch
S2—Normally-open momentary-
contact pushbutton switch
S3—SP6T rotary switch
S4—SPDT toggle switch
J1—Phono jack
PL1—Phono plug
BZ1—Piezoelectric buzzer
I1—6-volt incandescent lamp
Printed-circuit board materials,
enclosure, 7-conductor ribbon
cable, quad AA-cell battery holder
and connector, micro-alligator
clips, knob, 22 AWG and 26 AWG
stranded hook-up wire, solder,
hardware, etc.

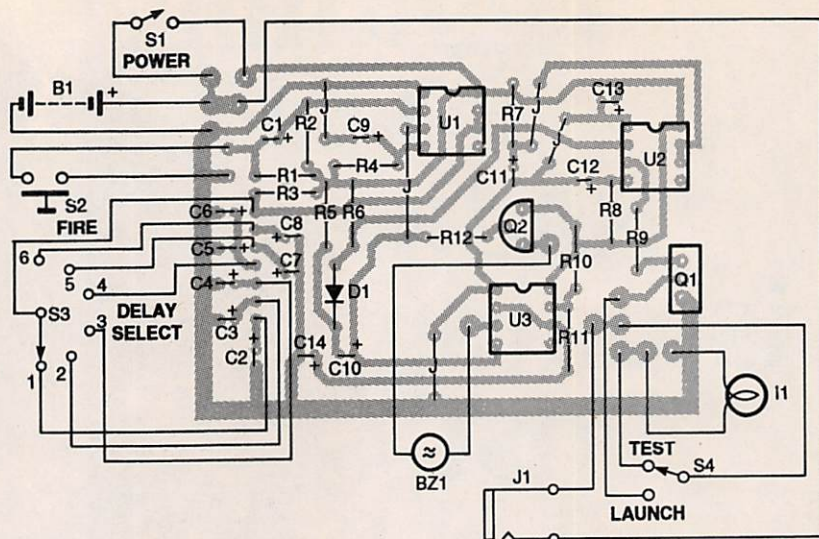


Fig. 3. Following this layout diagram, assemble the Time-Delayed Launch Control, keeping in mind that the polarized components must be installed with the proper orientation.

tween the board and the panel-mounted components.

Following the parts-placement diagram shown in Fig. 3, install the capacitors, making sure that they are all flush to the board, while observing their polarity. Likewise, install the resistors flat against the board. That minimizes lead lengths and gives a neater appearance. Install an 8-pin DIP socket at all IC (U1-U3) locations. That helps to eliminate the possibility of damaging the IC's, which are static sensitive, during soldering. Next, install transistors Q1 and Q2, taking care to properly align the emitter, base, and collector leads. Then, using hookup wire, or the excess leads clipped from the resistors, install the 5 jumper connections in the locations shown.

Cut six 8-inch lengths of 26 AWG stranded hookup wire. Twist pairs of wires together, making 3 pairs in all. Next, cut five 8-inch lengths of 22 AWG stranded hookup wire. Twist three of these wires together to make a 3-lead set for S4, and then twist the remaining pair together for S1. Once that's done, strip about an 1/8th inch of insulation from the ends of all the leads.

Solder one 26 AWG pair to the two printed-circuit pads that are identified as BZ1 in Fig. 3. Being careful to observe the correct polarity, solder the other ends of those leads to BZ1. Similarly, install the other two 26 AWG leads between the printed-circuit board and lamp I1, and the printed-circuit board and S2. Next, install the 3-

conductor 22 AWG wire set between the printed-circuit board and S4. Be careful to identify each of the three printed-circuit pads corresponding to the appropriate terminals of S4. Then solder the remaining 22 AWG pair between the printed-circuit board and S1.

Rotary switch S3 requires a 7-conductor cable. Use either 26 AWG or 28 AWG ribbon cable for S3. Cut an 8-inch length of 7-conductor cable and strip 1/8th inch from all ends. Following that, solder the cable to the appropriate printed-circuit board pads. Next, solder the other end of the cable to the rotary switch, making sure that lead number seven connects to the wiper. Install and solder the two leads coming from the battery holder to the printed-circuit board. Again, be certain to identify the correct polarity of each lead and each printed-circuit pad.

For the engine-igniter leads, cut two 3-foot or more lengths of 22 AWG stranded hookup wire. The actual length of this wire set depends on how far you want to place the control box from the launch pad—mine are about 3 feet. Once you've decided on the length, twist them together and strip about an 1/8th inch of insulation from both ends of each conductor. Solder a micro clip to one end of each lead. Push the other ends of the leads through the phono-plug sleeve, solder the two free ends to the tip and

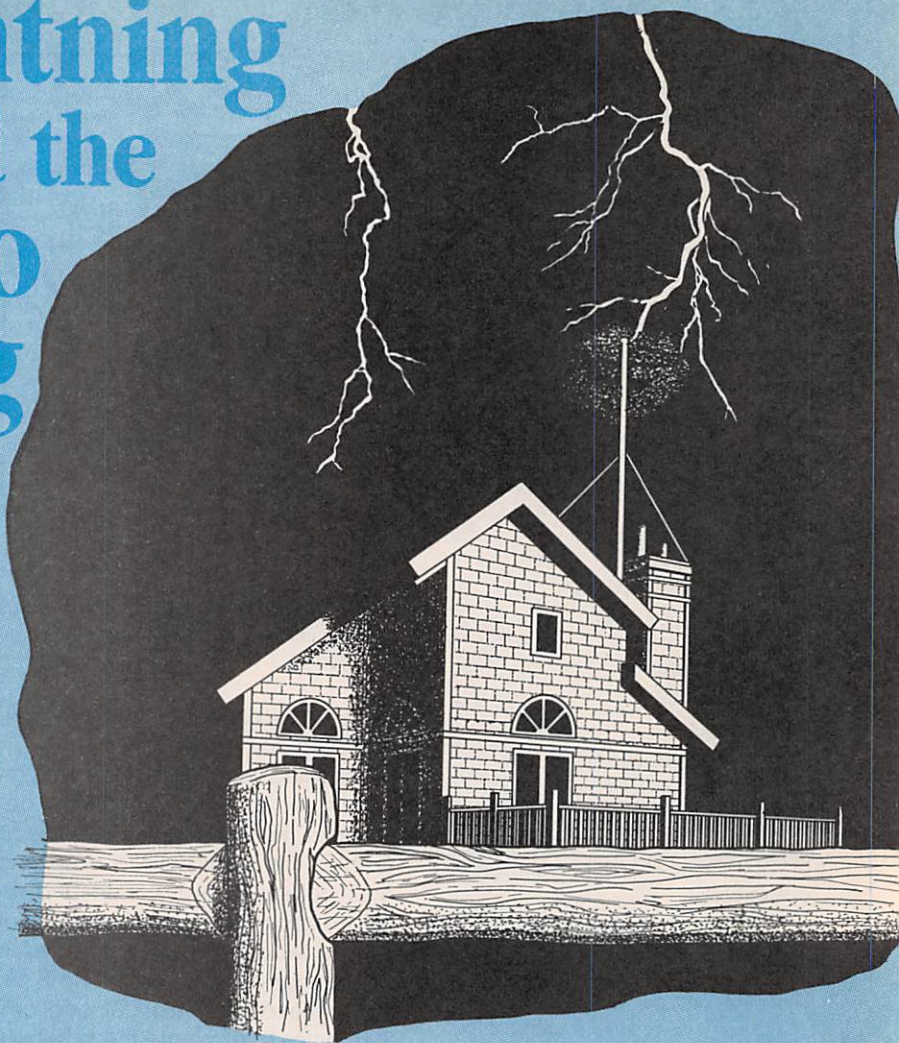
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leads and the 22 AWG and 26 AWG stranded hookup wire that will be used for the interconnections be-

Lightning and the Radio Listening Post

Here's the lowdown on lightning and how to protect your valuable equipment from those adverse pulses.

KARL T. THURBER, JR., W8FX



Lightning is real, lightning is dangerous, lightning kills. It's a natural phenomenon that can pack more than 200,000 amperes of raw destructive current in a single bolt. Each year over 100 people in the United States are killed by lightning, 500 people are injured, and over 10,000 fires are started.

So you should be aware of the possibility of damage to your radio and other electrical and electronic equipment, computers, telephones, FAX machines, modems, transmission lines, and antennas. Overvoltage conditions result in costly breakdowns and damage to your valuable equipment, but what can you do about it?

This article tells how to protect your radio listening post from lightning. We'll discuss what lightning is, why it's dangerous, and give examples of its destructive power. We'll also cover protection of AC power and telephone lines, antennas, towers, and transmission lines and proper grounding techniques. Accordingly, we'll cover lightning sensing and equip-

ment protection, and mention publications and equipment dedicated to lightning protection.

The Nature of Lightning. The legendary scientist, Ben Franklin, was the first to identify lightning as an electrical discharge through his famous kite experiment. It showed that lightning was a natural high-voltage discharge or electrical spark that takes place in the lower atmosphere between clouds or a cloud and the Earth.

The movement of air in weather patterns leads to the buildup of huge static electric voltages in clouds by accumulating charges through falling snow or rain. Negatively charged regions generally develop near the cloud bases and positively charged areas near the tops. When the voltage reaches a level where the air between a cloud and either the ground or another cloud can't insulate the charged cloud, an immediate and violent lightning bolt occurs.

The strike begins with a local breakdown of the atmosphere in the form of a "step leader." It steps about 150 feet every 50 microseconds, often over a distance of miles. The lightning-discharge core diameter is only 1-2 inches, while the electrified area surrounding this small core may be several feet in diameter. The intense fields created cause surrounding molecules to ionize.

The power exhibited during a lightning strike is enormous. The currents passing through the air in the discharge path are immense, and they can vaporize many materials. Potential differences of 100 million volts, or sometimes much more, may produce transient currents of up to 200,000 amperes.

Thunder is the audible sound wave generated by the lightning stroke. The sound of thunder appears to lag behind the lightning because of the relatively slow speed of sound compared with that of light; first you see the lightning and then you hear it.

Lightning: Why It's Dangerous.

Ninety percent of lightning discharges are of the harmless intra-cloud type, but when lightning seeks its path through the earth, its power to destroy is awesome, and it's dangerous to you and your equipment.

The lightning discharge's main frequency range is from DC to several MHz. The current reaches its peak in under 80 microseconds. The discharge declines less rapidly, in 200 microseconds or less. Although the discharge peaks and is over in a fraction of a second, that's long enough to exact a toll on buildings, trees, poles, homes, antennas, power lines, and anything else in its path.

Tall buildings and antenna towers can actually induce lightning discharges. Observers of lightning strikes on towers have noticed that an electrical leader sometimes appears to originate around the top of the tower, traveling upward into the cloud. Its streaked fingers point upward rather than downward.

Some Lightning Tales of Woe.

Besides the potential for physical damage to your home, even a nearby strike can wreak havoc. Transistors and integrated circuits can be destroyed. Capacitors and diodes can blow, receiver and transmitter antenna coils can melt, and contacts on RF switches can fuse. Not infrequently, your antenna rotor and rotor control box can be wiped out, and electrical fixtures and house wiring can be fused and melted.

One radio amateur I know experienced a direct hit on his station. The bolt destroyed the pole supporting his rhombic beam antenna, vaporizing the wire in the antenna itself. The RF stages of his receiver and the transmitter tank circuits weren't damaged since he had disconnected and grounded all his antennas, but the bolt knocked the nearby power-pole transformer to the ground.

All AC supplies left connected to the mains were burned out, unless they were fused on both sides of the line; all the AC power outlets in the home and most of the electrical wiring were damaged. Furthermore, many of the switch and relay contacts in various household appliances were burned or fused. In short, it caused a mess.

You're probably aware of the disastrous effects a direct lightning strike could have on your home and radio shack. But what of the "near miss" where lightning strikes nearby, causing your home to receive some lesser but still nasty and dangerous "induced effects?"

I suffered a nearby lightning strike several years ago, when a wayward



Most baluns place an antenna at DC ground potential and offer a limited degree of built-in protection from lightning-induced effects, though not from a direct hit.

lightning bolt struck somewhere in the neighborhood. While I couldn't find any physical evidence of the strike, its trail of "electronic death and destruction" wasn't hard to discover.

First, the telephones weren't working. The reason was that a new electronic memory phone had shorted out the phone line, apparently due to a surge on the line. I then found that the modems in both computers weren't working. I also found that several plug-in circuit boards on the two PC's had ceased to function, although the PC motherboards weren't damaged.

I also found that the meter in my Cushcraft vertical antenna's control box had shorted out, as had the small, hard-to-replace tuning motor at the

base of the antenna. Household TV sets went unscathed, although two cable TV (CATV) "block converters" also quit—the result of a surge or spike barreling down the CATV coax.

What surge suppression did I have installed? The computers and radio equipment were AC powerline protected, but I didn't have suppressors on the modems, telephones, rotor cables, or cable-TV line. I had erroneously thought surges on buried cable TV and telephone lines would be unlikely.

The AC-line surge suppressors helped that time, but more recently, during an electrical storm, I wasn't so lucky. A surge coming down the AC line was very selective, destroying an expensive VCR's power supply and that of a Bearcat scanner. Both devices were turned on at the time of the surge. They were both surge-protected, but the surge suppressors apparently didn't act fast enough to prevent damage, or the surge may have entered through the antenna.

The moral: buckle up your home and radio shack. While you can't do much about a direct hit, and you can't prevent all damage—as I found out—you can do a great deal to reduce the effects of a near miss. It can happen to you!

Protecting Your AC Power Lines.

While a direct hit by lightning is catastrophic and impossible to fully protect against, they are of low probability. The danger is that lightning strikes may be transmitted for a distance through utility lines as sufficiently large voltages all along the line. Most home lightning damage is caused by longer-duration high-voltage transients, called surges, and shorter-duration transients, or spikes, entering your home via the power mains. In fact, more than 90% of insurance settlements for lightning-related damages to homes and businesses are the result of lightning strikes picked up and carried by power lines.

While buildings themselves can usually survive high-intensity lightning strikes, electronic equipment is much less forgiving. The electronic circuitry in most electrical appliances is highly sensitive to voltage surges. Even relatively low-tech devices like furnaces and clothes dryers may have sensitive microprocessors within them. More

sophisticated devices such as short-wave receivers, scanners, VCR's, TV sets, amateur radio, and CB equipment are even more prone to electrical damage.

Point-of-Use Surge Suppressors.

For lightning strikes, in-line, shunt-type AC transient-voltage surge suppressors offer protection from spikes and momentary but potentially destructive overvoltage conditions. They do this by effectively clamping or limiting voltages to a safe level.

When you select a surge suppressor, whether of the conventional metal oxide varistor (MOV) or other silicon-based types, compare the performance specifications. The level of protection offered varies widely among similar-looking suppressors. Be suspicious of "no-name" suppressors for which specifications are not provided.

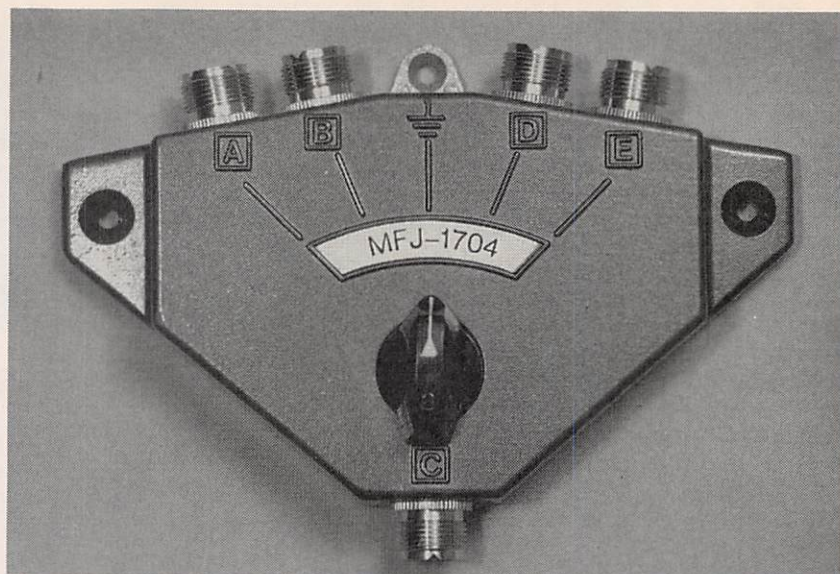
The total energy the unit can dissipate without burning out is a key selection criterion. The best models respond to block (without burning out) high-energy surges of at least 200 joules within a few nanoseconds; a 5-nanosecond response time (five billionths of a second) is typical. A joule is a unit of energy: one joule for one second is equal to one watt of power.

Another key spec is the clamping voltage, the voltage where the suppressor begins to block the surge. In practice, on three-wire residential 120/240-volt lines, look for a unit that has a low clamping voltage (around 300 volts or lower). Also, the unit should be capable of withstanding a surge voltage of at least 6500 volts and preferably 10,000 volts or higher.

Some surge suppressors also offer a measure of protection from electrical noise, such as broad-spectrum electromagnetic interference/radio frequency interference (EMI/RFI) reaching your equipment through the power lines. Such units can provide as much as 60 dB of filtering.

Whole-House Surge Protectors.

Ordinary circuit breakers react much too slowly to lightning-induced charges to be useful in protecting equipment and appliances. A so-called "whole-house" surge protector can protect all of the AC wiring circuits in your home from surges. You can mount one on the circuit breaker



The MFJ-1704 coax switch has a ground position, automatically grounds unused positions, and works to over 500 MHz. A replaceable surge protection device helps protect against lightning-induced surges.

panel, or you can obtain one that's installed as a mounting adapter behind your electric meter.

The newest, least expensive, and easiest to install whole-house surge suppressor is built into a standard double circuit breaker. To install it, you mount it into your electric breaker panel like any other circuit breaker and attach a single wire to ground.

Whole-house surge protectors still can't save your equipment from a direct hit, but they can do wonders protecting your gear from lesser but still damaging electrical perils. The better units can clamp within 10 percent of the rated current entering the home, protecting against lightning-induced surges of up to 15,000 amperes. By the way, you should compare warranties: some manufacturers of whole-house protectors and circuit breakers will replace any damaged electronic appliances up to a specified value.

For protecting radio equipment, a combination of whole-house and plug-in, point-of-use suppressors installed and grounded close to the protected equipment can be highly effective for AC surges.

In some cases you may need a line conditioner to solve chronic high or low voltage conditions. Indeed, power brownouts and sags are much more common disturbances and disruptions than are surges and spikes.

Are You Well Grounded? There's an old radio axiom that says, "When in

doubt, ground it." Nothing could be more true when it comes to effective lightning protection. However, not just any old ground will afford adequate protection.

Lightning behaves like many other natural elements in that it's looking for the path of least resistance or impedance. Should it hit your antenna it's looking for a ground connection. If the best path is through your equipment, you will have disastrous results. When lightning strikes, it's important to quickly divert as much of the strike's energy to ground as possible.

Consequently, the most important single element affecting the effectiveness of most conventional protection equipment and devices is the integrity of the ground to which they are connected. Your first line of defense is to have a good and short connection between your antenna and tower to a good ground.

There are big differences in grounds for RF grounding and RFI (radio-frequency interference) suppression, for power returns, and for lightning protection. A good ground for one purpose may not be so good for another. A ground for RF effectively takes the place of "the other half" of a normal dipole (as in a ground-plane antenna), and often helps improve station efficiency and reduce RFI to nearby TV sets and radios.

A second type of ground is the power return or safety ground for electrical ground faults—your home's

power-line grounding system. This is a good ground for low frequencies (such as 60-Hz AC power) but may not be a good ground for RF or lightning. The third type is the lightning ground, which must be capable of handling high but short-duration currents; it's that type of ground we are most concerned with in this article.

Inside the Radio Shack. There are several things you can do to minimize lightning-related risk within the shack. You should connect all metal cabinets, control boxes, and shielded cables to a common ground bus or wire. The bus should, in turn, be connected to the main station ground system (a cold water pipe and/or outdoor ground rods) and the home electrical ground system. Gas or electrical conduit pipe shouldn't be used for grounding.

Several firms offer means of effecting common-point grounding of all station equipment. J. Martin Systems offers an inexpensive accessory, the Ground It bus, to facilitate common-point grounding. The bus helps protect equipment and makes chassis-ground connections short, with all the benefits good grounding brings. The Ground It system is a 1/2-inch by 1/2-inch solid-copper bus that provides an equipment grounding stud every six inches. The firm recommends a short but heavy gauge wire or grounding strap be used to make connections to a good earth ground, such as a six- to eight-foot ground rod. Four lengths are offered, from two to six feet, from \$11.95 to \$31.95.

Outdoors. Several six to eight-foot ground rods connected together with

heavy-gauge wire will usually provide a satisfactory ground outdoors. The more rods the better.

The main ground conductor should at the very least be a No. 8 wire. While the ground lead may be either insulated or bare, or even heavy copper braid, it should be protected from mechanical injury from lawnmowers, digging, and gardening. It should be connected to the ground rod through the shortest path possible with no sharp bends. Some operators even use small-diameter copper tubing as the connecting wire.

If your soil is dry and sandy, for best protection you should use at least two ground rods spaced at least 6 feet apart and bonded together by heavy wire or copper ground braid. You also can increase soil conductivity and help retain water by "doping" the soil with special salt compounds.

As for materials, inexpensive TV-type grounding hardware is a good value. The heavy No. 8 or 10 aluminum wire sold for grounding TV antennas is good, as are TV-type ground clamps. But be leery of using standard TV ground rods, as they are usually shorter than they should be.

Protecting Your Tower. A high tower or mast doesn't necessarily invite disastrous consequences during electrical storms, despite the fact that the frequency of strikes increases with height. Many radio enthusiasts have operated for years with towers that were the highest objects in the vicinity without suffering damage.

If there's a secret to protecting antennas, towers, transmission lines, and the radio shack, it lies in you—and not Nature—controlling the lightning

strike's energy. That means you must provide a direct path to ground so that the electrical charges picked up from the atmosphere during an electrical storm will be discharged directly and harmlessly to the earth, instead of through expensive equipment or your home. If you do the job right, the worst of the discharge will pass to the earth before blowing your radio shack away.

Ground all towers and masts, including those mounted on roofs. Metal towers are usually well grounded and don't need ground wires run up through the tower, although several ground rods can be attached to the tower legs. With wooden towers, you should run a very heavy ground wire all the way to the hardware on top of the tower.

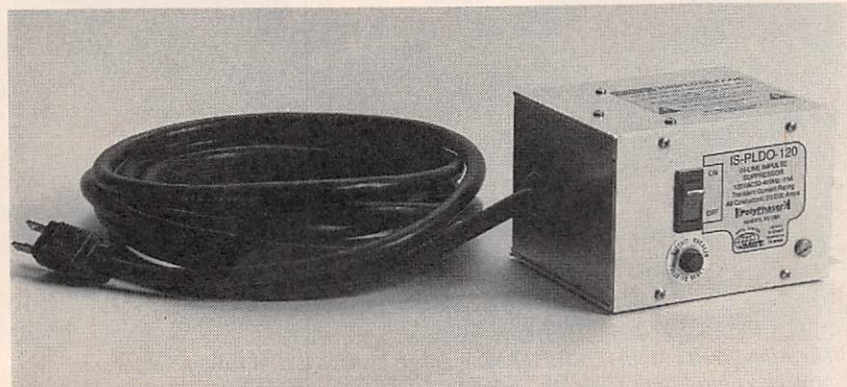
If you have several coaxial cables coming off a tower, you might want to install cable-grounding blocks. They can help shunt lightning-induced voltages and establish a common-point neutral ground. Also arrange for some distance between the tower itself and the entry point of the transmission line to your home. Doing that will provide an opportunity for the ground to absorb strike energy before it enters the radio shack.

The good news is that a properly grounded tower can create a "cone of protection" over the property lying below it. Thus, the tower offers some protection to nearby lower structures, but only if it has a good, direct, low-impedance ground—one that has low ground resistance and inductance/capacitance values. The cone of protection can be enhanced by a copper, brass, or steel lightning rod at the very top of the tower, clamped to a mast extension above all the antennas. The sharp pointed rod discharges the immediate area around it before a large static buildup occurs.

Protecting Your Antenna.

Generally, all-metal beam antennas are partially self-protecting by their very construction: they are usually at DC ground potential through the mast and tower that support them. That protection assumes good connections, so it's wise to use an antioxidant conductive-grease compound to ensure solid contact and help prevent corrosion.

If you want to use a dipole or other



The PolyPhaser Model IS-PLDO-120 inline multistage AC protector has multi-strike capability and is circuit breaker for added protection. The unit can be mounted and grounded to a single-point ground plate. RFI filtering also is provided.

antenna that normally uses a balanced (open-wire) transmission line, consider placing a balun at the antenna to allow coaxial feedline to be used. The balun, or balanced-to-unbalanced transformer, converts from the unbalanced coax to a balanced output by transformer action. Most baluns put the antenna at DC ground potential, offering a limited degree of built-in static-buildup and lightning protection.

Multiband antenna traps are unprotected from damage during an electrical storm, and induced currents from nearby discharges may cause damage. While it's possible to construct wire spark gaps across the traps, doing so may upset their operation. From a practical standpoint, traps can remain unprotected. Just replace them if they're damaged.

Don't forget to protect the ground-plane antenna. When this type of antenna is elevated above the ground, run a direct ground wire to its radial system. Don't rely on the coax feedline shield alone to provide grounding and lightning protection.

Protection for Your Transmission Line. Although the antenna proper may be well grounded at the business end, the transmission line can cause damage to your home or radio equipment if left unprotected, by acting as a conduit for static discharges. A good place to protect the coax line is where it enters the building.

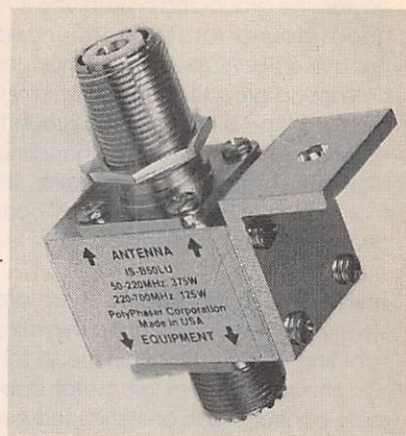
Radio operators and commercial users often install coaxial bulkhead-adaptor connectors on a sheet metal bracket on the outside of the building where the cable enters, using an air-gap type of lightning protector in the coax line. The bracket is grounded using a length of No. 10 or larger wire to a ground rod.

Bulkhead adapters aren't easy to find these days, though you can purchase commercial bulkhead panels. A popular alternative is to simply install a commercial, preferably hermetically-sealed gas-discharge type plug unit or lightning arrester in the feedline where it enters the building. While nothing can promise protection from a direct strike, such units can head off problems from nearby discharges that might induce high voltages and currents in your equipment by bleeding off the charges.

Such units have a very short turn-on time. They contain a small spark gap that won't arc or short out even if you transmit through them, but will allow all high-voltage discharges to bridge the gap and be blocked and diverted harmlessly to ground. Several manufacturers offer such devices at very reasonable prices. At least one firm (Design Electronics Ohio, or DEO) offers units specifically for receiver protection (these are available from Universal Radio, Inc.).

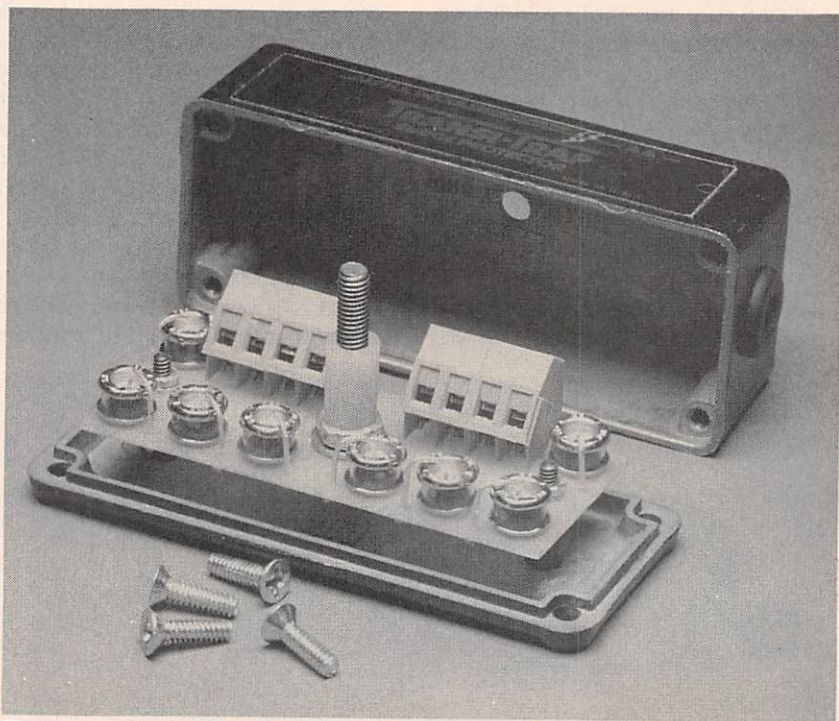
It's also a good idea to use an antenna-selector switch that automatically grounds all antennas except the one in use and that has enough positions so that you can turn the antenna selector to an unused position when not using the equipment. Putting a couple of loops in your coaxial transmission line, either near the antenna or where the coax enters the radio shack, may also help prevent discharges from entering the shack.

While coaxial cable is the most popular and practical transmission line today, for receiving you can protect a flattop fed with ladderline or twinlead using a TV-type lightning arrester; just don't transmit, which might short out the device. Commercial



The PolyPhaser IS-B50LU broadband HF/VHF/UHF coaxial transmission-line protector is designed for bulkhead mounting. Available in three different models covering 1.5 MHz to over 1000 MHz, these general-purpose models work on most equipment, including receivers.

balanced-line suppressors are also available, though expensive. However, The Wireman, Inc., offers an inexpensive air-gap lightning arrester (\$26.50) for ladderline, plus a heavy-duty double-pole single-throw knife switch (at \$7.95) to shunt parallel transmission lines to ground when you're not using your gear.



The Alpha Delta Model CLP Lightning Surge Protected Control Line Protector protects control lines to rotors, switches, telephones, and other equipment. The \$49.95 device can protect up to eight wires. Each is protected by a field-replaceable current gas tube Arc-Plug cartridge. During the period of a transient, the cartridges toggle to ground, effectively shunting the spike to ground.

NAMES AND ADDRESSES

Alpha Delta Communications, Inc.
1232 E. Broadway, Suite 210
Tempe, AZ 85282
Tel. (602) 966-2200.

Ameritron
116 Willow Road
Starkville, MS 39759
Tel. (601) 323-8211

Global Computer Supplies
1050 Northbrook Pkwy.
Suwanee, GA 30174
Tel. 1-800-845-6225

Industrial Communications Engineers, Ltd.
P.O. Box 18495
Indianapolis, IN 46218-0495
Tel. 1-800-423-2666.

LPS Enterprises
308 Sterling Dr.
Warner Robins, GA 31088
Tel. (912) 929-9416

MFJ Enterprises, Inc.
P.O. Box 494
Mississippi State, MS 39762
Tel. 1-800-647-1800.

J. Martin Systems
35 Hilltop Ave.
Stamford, CT 06907

McCallie Manufacturing Corp.
P.O. Box 77
Brownsboro, AL 35741-0077
Tel. (205) 776-2633

S.P. McGreevy Productions
45 Elda Drive
San Rafael, CA 94903

PolyPhaser Corporation
2225 Park Place, P.O. Box 9000
Minden, NV 89423-9000
Tel. 1-800-325-7170

Rabun Labs, Inc.
4407 Vineland Rd., Suite D-18
Orlando, FL 32811
Tel. 1-800-788-1824

Radioware Corp.
87 Belmont St.
N. Andover, MA 01845
Tel. 1-800-950-9273

Spi-Ro Manufacturing, Inc.
P.O. Box 5500
Lakeland, FL 33807
Tel. (813) 646-7925

Tytwadd Power Filters
704 W. Battlefield Rd.
Springfield, MO 65807
Tel. (417) 887-3770

Unadilla Manufacturing Co., Inc.
P.O. Box 4215
Andover, MA 01810
Tel. (508) 475-7831

Universal Radio, Inc.
6830 Americana Pkwy.
Reynoldsville, OH 43068
Tel. 1-800-431-3939

The Wireman, Inc.
261 Pittman Road
Landrum, SC 29356
Tel. 1-800-717-9473

In any case, lightning arrestors, of whatever type, installed in the transmission line—especially if located indoors at the back of a receiver or transmitter—should be considered to offer only secondary protection from static buildup, or to divert whatever is left of a nearby lightning strike. The primary protection should be the measures you take with the tower, antenna, and transmission line outdoors.

Protecting Your Modem and Telephone Equipment. Most of us protect sensitive electronic equipment from potentially damaging powerline surges. But few of us apply similar protection to the telephone line for the well-being of modems, phone patches, telephones, and FAX machines.

The telephone wiring entering your home can route dangerous transients to your equipment. Microprocessors and other solid state devices are

often blown by phone-line spikes that are insufficient to trigger the telephone company's line protector, but which are strong enough to affect individual devices connected to the line.

Theoretically, no damage to electronic equipment should occur if the phone line is properly installed and protected by the telephone company. Most home telephone circuits are protected at the point the phone line enters the home by a device designed to short to ground when the voltage exceeds a preset level. But this voltage is relatively high, and the suppressor may not act fast enough to be effective. It may also be burned out.

While cases of a telephone-line surge passing through the modem to damage the computer itself are rare, it can happen. You can eliminate that possibility by disconnecting the modem and other expensive devices

connected to the telephone line whenever dangerous weather conditions dictate.

Surge suppressors are available to further reduce or eliminate this source of damage. Inexpensive commercial protectors are available from most computer, electronics, and office-supply houses and distributors. The desirable surge ratings of modem and FAX suppressors are similar to those for AC surge protectors. Many AC surge protectors also feature telephone protection as an added feature.

Lightning Sensing. Another old radio saying is that, during a storm, the only safe conductor is a grounded conductor. That means that antennas should be disconnected and grounded whenever a storm develops. You can do that manually, guessing the presence of a storm or relying on special sensors, or it can be done automatically by lightning-detection devices.

To that end, McCallie Manufacturing Corp. offers Stormwise Lightning Alert advance storm warning and lightning sensors. These devices warn that thunderstorms, with the possibility of dangerous lightning, are approaching your area—before you can see the lightning or hear the thunder. The warning gives you time to shut down and disconnect your equipment.

One example of their products is the Model LSU-222A Lightning Storm Detector. It has an omnidirectional sensor that alerts you to approaching cloud-to-ground lightning strikes. The device indicates if the lightning is far or near by the volume of the alarm warning tone, which sounds on each lightning strike detected. A three-way alarm feature lets you choose a loud alarm, hear each unique lightning return-stroke "signature pattern," or have the alarm beep when a "lightning burst" (of 40 or more strokes per second) is detected.

The weatherproof, \$29.95 (plus \$3 S/H) device uses a patented Extremely Low Frequency/Very Low Frequency impulse sensor said to provide accurate warnings over extended ranges, with immunity to manmade or radio-skip static. The sensor, which includes a buzzer alarm, mounts on a TV mast or pole. It draws no power from its

battery unless lightning activity is sensed. When it detects lightning, the sensor drops from an infinite resistance to a level where current flows through it, activating an alarm. (You do have to provide some common parts—a 9-volt battery and connector, cable, ground rod and wire, on/off switch, and other small parts—yourself.)

You can also use the device with a computer for recording and graphing real-time lightning data. The optional computer program records, counts, and graphs over 100 lightning detections per second. The \$39.95 software program includes the software diskette, instructions, and an electrically isolated serial port interface for the LSU-222A detector.

LPS Enterprises offers inexpensive antenna switching and automatic antenna-, modem-, and rotor-disconnect products. Centerpieces of the line are the ASW-series coaxial-antenna switches, that come with or without the automatic antenna-disconnect feature. The devices switch between two or three antennas and protect equipment from discharges when not in use. They operate on 12 VDC, using the same power source as your radio equipment. When power is shut down, the antennas are disconnected and equipment inputs are grounded. Several versions are available starting at \$39.

LPS Enterprises also offers the AMD-1 Automatic Modem Disconnect system. It protects your computer's modem from static discharges and voltage surges; when you shut down, the phone line to your equipment is disconnected. Another device is the ARD-1 Automatic Rotor Disconnect. It protects your rotor control box in a similar manner. When power is shut down, the control box is disconnected and the inputs to the rotor are grounded. The \$39 device handles up to eight lines.

For protective systems that may approach the "ultimate" in equipment protection, Rabun Labs offers several versions of its Incipient Lightning Detection and Protection (ILD/P) System. The Rabun ILD/P system continually monitors the atmosphere and detects the presence of lightning when a storm is two to ten miles away. It looks for specific signal profiles and lightning signatures and filters out fre-

quencies occupied by manmade devices. The system protects equipment by automatically disconnecting everything: AC power, coaxial cables, and telephone lines. The system automatically restores power and other connections after a period of time and when the storm has passed safely out of the local area.

Rabun Labs offers about a dozen ILD/P models for amateur-radio and other two-way communications gear, radio-receiving equipment, satellite-receiving systems, PC's, well-pump motors, air-conditioning compressors, and more. Other models automatically power standby AC-power generators and provide emergency notifications and alarms, detect power surges, or just provide warnings. Prices range from under \$200 to \$1000, depending on the application and features.

Publications and Catalogs.

PolyPhaser Corporation's *Lightning/EMP and Grounding Solutions* catalog is a valuable reference for lightning suppressors and protectors, grounding products, and test equipment. Several pages are devoted to highly instructive lightning-protection and grounding information.

Hundreds of commercial- and military-quality products are offered. They include coaxial-cable impulse, data/telephone-line, power supply, and inline power-mains protectors; copper straps and grounding clamps; ground rods; gas-discharge tubes; bulkhead-entrance panels; test equipment; and more. The company also offers a free newsletter, appropriately titled *Striking News from PolyPhaser*.

Grounding is so important that the company also produced a book about it. They offer Roger R. Block's 95-page, 8½ x 11-inch reference book, *The Grounds for Lightning & EMP Protection*. The Second Edition features very comprehensive information analyzing proper techniques for grounding and protection against lightning. The book's emphasis is on radio communications, telephone, computer, office, local-area network (LAN), CATV, and TVRO use. Though primarily oriented toward commercial installations, the book is written in a non-technical manner. It's available for \$22.95.

Industrial Communication Engineers, Ltd.'s catalog shows a wide range of low-cost antenna-accessories for amateur, commercial, and government applications. RFI filters, signal splitters, RF-tight enclosures, coax lightning suppressors, grounding blocks, ground-rod mounts, tower-leg mounting kits, and rotor-cable voltage suppressors are offered. Also featured are guy-wire grounding kits, cable assemblies, lightning-protected longwire and Beverage-antenna resistive loads and matchers, CATV/TVRO suppressors, chemical-treatment products, and related accessories.

ICE engineers have prepared several one-page technical publications for customer use. They are single-sheet, 8½ x 11-inch reports that cover a variety of subjects related to the use of ICE and competitors' products, station design and construction, and lightning protection. The concise publications are written in easy-to-understand, non-technical language.

Topics in the area of lightning protection and grounding include: lightning protection for radio facilities (publication numbers 30, 30A, and 30B); grounding techniques (numbers 31 and 31A); water-pipe and service-joint grounds (number 32); comparative analyses of coax lightning arrestors (numbers 33, 33A, and 33B); grounding coax-cable shields (number 36); using anti-oxidants for good interconnections (number 60); and DC-grounded antennas (number 80). Industrial Communications Engineers also offers a listing of the free publications and a catalog.

Wirebook II is a very concisely written, 56-page booklet that is billed as a how-to-do-it source manual for coaxial cable and connectors, antenna wire, baluns, lightning protection, grounding, and RF and antenna accessories available from The Wireman, Inc. Not a technical report, it's a highly readable collection of hints, tips, and advice from a variety of sources. The *Wirebook II* is \$2.

In summary, while you can't prevent lightning, learning something of its properties might help you protect yourself and your equipment from at least some of its destructive potential. We hope that this article has helped you do just that. Don't wait for lightning to strike. Protect yourself now. ■

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WCES 94: Where's the Hype?

This past January in Las Vegas, something different could be found on the floor of the 1994 Winter Consumer Electronics Show: feet. Manufacturers' feet, to be precise—planted firmly on the ground. That's quite a departure from the usual "head-in-the-clouds, pie-in-the-sky" posturing that's been standard fare at recent Consumer Electronics Shows.

At WCES 94, the emphasis was on product, not prototype. Real products that we could see, feel, hear, and play with on the show floor—and that *you* can buy in local stores. MiniDiscs, digital compact cassettes (DCC), personal digital assistants (PDA), and 3DO players have been on the shelves since last year. The first satellite for Thomson's Digital Satellite System (DSS) system was launched in late December 1993. DSS will be available in some markets by the time this magazine hits the stands, as will the StarSight on-screen program guide/automatic VCR programmer.

For the most part, progress reports re-

placed promises, but that doesn't mean that the consumer-electronics industry is forsaking the future for immediate profits. There was plenty of talk about the coming information superhighway and what it might mean in terms of new consumer-electronics products and services.

Still, the distinct lack of hype—at least in comparison to past shows—made WCES 94 seem quieter than usual. In reality, that was not the case. In fact, the show set a record for the amount of exhibit space, breaking the 1,000,000-square-foot mark for the first time in CES history. Attendance was up as well, with more than 82,000 attendees registered by noon on day three of the show, compared to a total attendance of 78,500 last year. In general, exhibitors and attendees alike had an upbeat attitude, coming off a good Christmas selling season.

In its physical layout, the Winter Consumer Electronics Show reflected the recent convergence of some technologies, and the entry of other technologies into the realm of consumer electronics. AT&T, for instance, moved from the telephone-exhibit area to the main floor. The company still exhibited phones, but the emphasis at the booth was on interactive networked multimedia in a variety of formats. The computer industry was out in force, with a record number of hardware and software

manufacturers displaying a wealth of multimedia titles and machines, along with more traditional computer products. Apple Computers was on the main floor for the first time, as was Intel.

So, despite the less frenzied atmosphere, there was plenty to see at WCES 94. In this article, we'll provide a status report on the things you can buy now, and a look at what's being touted as the future of consumer and communications electronics. Throughout this article we'll highlight coverage of the more interesting products that made their debuts at the show.

The Here and Now

Multimedia, PDA's, and other computer-related products might be the headline makers, but the bulk of consumer-electronics dollars is still spent in traditional product categories—audio and video, in particular. In both of those categories, recently introduced technologies deserve mention.

Adventures in audio

In the audio world, the MD-versus-DCC battle plods on—albeit leaving the average consumer untouched and unimpressed. Nevertheless, several new MiniDisc products were introduced, most by Sony, and dramatic price breaks made news on the DCC front.





Keep an eye out this spring for Thomson's DSS kiosk in a store near you.

Another audio technology that has yet to touch the lives of most consumers is RBDS: Radio Broadcast Data Service. The roll-out continues, with heavy backing from the Electronic Industries Association Consumer Electronics Group (EIA/CEG).

Although we heard total MiniDisc 1993 sales figures of 70,000 bandied about, Sony was the only company quoting solid numbers. That company shipped some 50,000 units to dealers in U.S. alone last year. That might not sound like much, but it's far higher than the first-year figures for VCR's or CD players.

Newcomers to the MD camp include Clarion and Denon; Kenwood, Sharp, and Sanyo also displayed new products. Clarion's four-disc, in-dash MD changer should be available in April for \$999. Kenwood announced a \$1299 home MD deck, sized to fit mini-component systems. Sharp's first MD portable with record capability will be in stores by May. Designed for low power consumption, it uses a rechargeable lithium battery that provides 2½ hours of playback or 2 hours of recording on a single charge. An optional alkaline battery pack provides up to nine hours of playback time. Sanyo's three-disc, in-dash AM/FM/MD changer with detachable faceplate will be available in June for \$1499.

Sony introduced a full line of second-generation MiniDisc products at the Winter Consumer Electronics Show. It included the company's first MiniDisc in-

dash car changer/tuner, the four-disc MDX-400 (\$1299.95); the MDX-40 four-disc component MD changer (\$999.95); and the MDX-100 in-dash MD receiver (\$999.95). Although Sony has touted MiniDisc as a portable format, the company introduced a full-size, full-feature home deck, the MDS-501 (\$999.95), with advanced disc-recording and editing capabilities. Sony's portables have become more so: The cassette-case-sized MZ-E2 MD player is half the size of its predecessor, and the MZ-R2 MD Walkman recorder is 60% smaller than the first-generation model. Unfortunately, prices haven't dropped proportionately; suggested retail prices for the MD player and recorder are \$549.95 and \$749.95.

DCC is still alive, if perhaps not kicking as strongly as MD. No new DCC manufacturers were announced at the show, and few new products were introduced. However, those new products—and some 1993 models—featured significantly lower prices than their predecessors. A new home DCC deck from Technics will carry a suggested retail price of \$599 when it ships in June, compared to the \$999 price

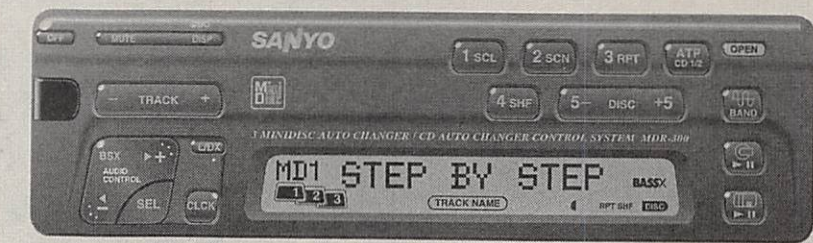
tag of the company's previous home deck. Marantz announced similar price cuts on its home DCC decks.

Both camps announced publicity campaigns designed to educate consumers about their products. Sony has teamed with *Rolling Stone* magazine in a promotion that will give one-million magazine subscribers a free MD sampler, which will be attached to the cover of the magazine—a unique way to make “the cover of *Rolling Stone*,” as the song goes. On the DCC front, Philips has been offering free DCC cassettes to those who buy the company's portable DCC player.

It remains to be seen which format—if any (or both)—will prevail with consumers. MiniDisc appears to be more robust to date, due in part to its use of optical technology, sure to appeal to those who already appreciate the benefits of CD. DCC's backward compatibility with standard audio cassette tapes sounds like a good idea—but is it realistic to expect those who are still collecting tapes (many of whom haven't even adopted CD's yet) to fuel the introduction of a new digital audio technology?



Sharp introduced its first portable MiniDisc player with record capability, the model MD-M11.



Sanyo's MDR-300 in-dash, 3-disc MiniDisc changer features a detachable face plate.

Senior Writers: Chris F. O'Brian, Teri Scaduto. ©Gernsback Publications, Inc., 1994. Gizmo is a registered trademark. All rights reserved.

Also making audio news at WCES 94 was the Radio Broadcast Data System, or RBDS, the technology that allows radio broadcasters to transmit digitally displayed text along with their regular programming. Consumers who own RBDS radios will be able to see displayed radio station call signs and frequencies, traffic and weather alerts, artist or programming information, and advertisements. The RBDS service, which is sometimes misnamed "video radio," is currently being broadcast by more than 80 FM stations in the United States.

The EIA/CEG is actively pushing RBDS with a promotional campaign that targets broadcasters as well as consumers. Plans unveiled at the show include offering the top six stations in ten major markets the chance to test out RBDS technology for free. Stations in Atlanta, Boston, Dallas, Los Angeles, Miami, New York, Philadelphia, San Francisco, Seattle, and Washington, D.C., will receive comprehensive information kits along with an RBDS encoder (model RE-533 from RE America). A print and electronic media campaign will round out the promotion. According to Gary Shapiro, group vice president of the EIA/CEG, "By providing an opportunity for radio stations to sample the benefits of RBDS technology and extend those benefits to consumers, the EIA hopes to build momentum for RBDS demand in the United States."

As that demand grows, several companies—including Denon, Jensen, Delco, Blaupunkt, Panasonic, and Goldstar—will meet it. Denon is also conducting a promotional campaign, offering 40 radio stations the RE-533 encoder in exchange for ad time that will be used to introduce Denon's RBDS gear.

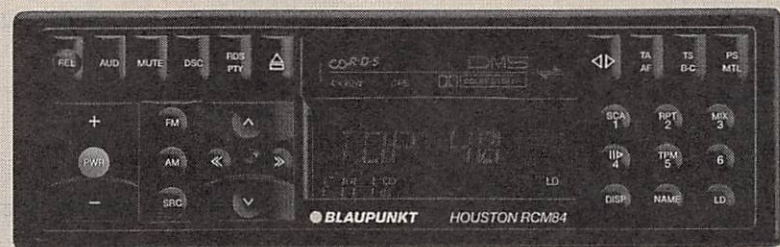
Take control of your video

A group of seemingly disparate video products and technologies displayed at WCES 94 have the empowerment of the viewer in common. An array of devices promises more control over programming and program providers, more channels to choose from, better audio and video quality, easier VCR time-shifting, clever remote controls, and even freedom from commercials.

Perhaps the most exciting development in the video sector is the launch—and we mean that literally—of Thomson's Digital Satellite Service, or DSS. Those of you who already own home satellite systems might have caught the December 16th launch of the high-powered Hughes DBS1 bird from French Guiana. (A second satellite is scheduled for launch in June.) Many more people will now be able to experience some of the benefits of direct satellite broadcasts—superior audio and video quality and greater programming vari-



The second-generation MD line from Sony includes portable, automotive, and home MiniDisc products.



Blaupunkt's Houston RCM84 FM/AM/cassette receiver with CD changer control offers RBDS capability.



The RBDS receiver/cassette player from Delco receives and decodes the digital RBDS signal, and displays text messages.

ety—using a stationary dish that measures only 18 inches in diameter and a set-top DSS IRD (integrated receiver/decoder). The entire system will cost between \$700 and \$900, not including installation (add another \$200 to hire a pro; DIY kits will be available for under \$100).

When both high-powered satellites are transmitting programming, as many as 150 channels will be available. Those will include most major cable services, such as HBO, Encore, Cinemax, ESPN, the Sci-Fi Channel, Discovery, the Disney Channel. Pay-per-view movies and sporting events also will be offered. Because of DSS's

available channel capacity, popular movies will be shown on multiple channels with starting times every half-hour or so. Digital audio and data services are also planned. (To receive basic network services, however, you will still require an antenna or cable box.)

In some ways, the DSS system is actually a cross between satellite systems and cable service, with some of the benefits of the former and drawbacks of the latter. Although it can't compete with the more than 200 channels available to standard TVRO owners, DSS makes up for that in convenience; it offers easy on-screen pro-

NAMES AND ADDRESSES

AMERICA ONLINE, INC.
8619 Westwood Center Drive
Vienna, VA 22182-2285
CIRCLE 50 ON FREE INFORMATION CARD

APPLE COMPUTER, INC.
20525 Miriani Ave.
MS 305 4Q
Cupertino, CA 95014
408-974-9717
CIRCLE 51 ON FREE INFORMATION CARD

ARISTA ENTERPRISES, INC.
125 Commerce Drive
Hauppauge, NY 11788
516-435-0200
CIRCLE 52 ON FREE INFORMATION CARD

AST COMPUTER
16215 Alton Parkway
Irvine, CA 92718
714-727-4141
CIRCLE 53 ON FREE INFORMATION CARD

ATARI CORPORATION
1196 Borregas Avenue
Sunnyvale, CA 94089
408-745-2019
CIRCLE 54 ON FREE INFORMATION CARD

AT&T CONSUMER PRODUCTS
5 Wood Hollow Road, 3L11
Parsippany, NJ 07054
201-581-3000
CIRCLE 55 ON FREE INFORMATION CARD

AT&T INTERACTIVE PRODUCTS
919 East Hillside, Suite 275
Foster City, CA 94404
415-578-1761
CIRCLE 56 ON FREE INFORMATION CARD

BLAUPUNKT
2800 South 25th Avenue
Broadview, IL 60153
708-865-5654
CIRCLE 57 ON FREE INFORMATION CARD

CASIO, INC.
570 Mt. Pleasant Ave.
Dover, NJ 07801
201-361-5400
CIRCLE 58 ON FREE INFORMATION CARD

CLARION SALES CORPORATION
661 W. Redondo Beach Blvd.
Gardena, CA 90247
310-237-9100
CIRCLE 59 ON FREE INFORMATION CARD

COMMODORE INTERNATIONAL LTD.
1200 Wilson Drive
West Chester, PA 19380
CIRCLE 60 ON FREE INFORMATION CARD

COMPAQ COMPUTER CORPORATION
P. O. Box 692000
Houston, TX 77269-2000
713-374-0670
CIRCLE 61 ON FREE INFORMATION CARD

DCC GROUP OF AMERICA
1900 South Sepulveda Blvd. #311
Los Angeles, CA 90025
310-478-3110
CIRCLE 62 ON FREE INFORMATION CARD

DELCO ELECTRONICS CORPORATION
One Corporate Center
Kokomo, IN 46904-9005
317-451-0658
CIRCLE 63 ON FREE INFORMATION CARD

DENON AMERICA, INC.
222 New Road
Parsippany, NJ 07054
201-575-7810
CIRCLE 64 ON FREE INFORMATION CARD

DIRECTV
P. O. Box 92424
Los Angeles, CA 90009
310-535-5062
CIRCLE 65 ON FREE INFORMATION CARD

ECLIPSE MOBILE ELECTRONICS
19600 South Vermont Ave.
Torrance, CA 90502
310-532-3062
CIRCLE 66 ON FREE INFORMATION CARD

EIA/CEG
2001 Pennsylvania Ave. NW
Washington, DC 20006-1813
202-457-8700
CIRCLE 67 ON FREE INFORMATION CARD

GEMSTAR DEVELOPMENT CORPORATION
135 N. Los Robles Avenue
Suite 870
Pasadena, CA 91101
818-792-5700
CIRCLE 68 ON FREE INFORMATION CARD

GOLDSTAR ELECTRONICS INTERNATIONAL, INC.
1000 Sylvan Avenue
Englewood Cliffs, NJ 07632
201-816-2000
CIRCLE 69 ON FREE INFORMATION CARD

INTEL CORPORATION
2200 Mission College Blvd.
San Jose, CA 95052
CIRCLE 70 ON FREE INFORMATION CARD

INTERNATIONAL JENSEN, INC.
25 Tri-State International Office Center
Suite 400
Lincolnshire, IL 60069
800-323-0707
CIRCLE 71 ON FREE INFORMATION CARD

INTUIT
P. O. Box 3014
Menlo Park, CA 94026
CIRCLE 72 ON FREE INFORMATION CARD

JVC COMPANY OF AMERICA
41 Slater Drive
Elmwood Park, NJ 07407
201-794-3900
CIRCLE 73 ON FREE INFORMATION CARD

KENWOOD USA CORPORATION
2201 E. Dominguez
P. O. Box 22745
Long Beach, CA 90801-5745
310-639-9000
CIRCLE 74 ON FREE INFORMATION CARD

MARANTZ USA
1150 Feehanville Drive
Mount Prospect, IL 60056
708-299-4000
CIRCLE 75 ON FREE INFORMATION CARD

MEDIAVISION
47300 Bayside Parkway
Freemont, CA 94538
510-770-8600
CIRCLE 76 ON FREE INFORMATION CARD

gramming guides, does not require repositioning to pick up different satellites, and is easier to install and not as obtrusive as a large dish. And although DSS's quality and programming choices leave today's cable systems in the dust, DSS owners still won't have the myriad package options available to TVRO owners (nor will they be able to pick up the wild feeds and oddball shows that make TVRO channel flipping so interesting). Only two suppliers—

USSB and DirecTV—are offering programming packages, but most cable subscribers would agree that two is better than one, and between the two a wide variety of packages will be available. Programming packages from each supplier will cost between \$8 and \$30 a month. Also, when HBO is offered in a DSS package, you won't see one channel but five—HBO East, HBO West, HBO2 East, HBO2 West, and HBO3.

To help viewers decide what to watch (and what *not* to watch), DSS provides such convenience features as an on-screen program schedule and parental lockout based on channel or rating. Parents can also set a time limit on the amount of pay-per-view programming their kids can order.

Even those couch potatoes with the mere 30-or-so channels offered by their local cable companies—or just standard

NAMES AND ADDRESSES

MOTOROLA WIRELESS DATA GROUP
1201 E. Wiley Road
Suite 103
Schaumburg, IL 60173
708-576-0453
CIRCLE 77 ON FREE INFORMATION CARD

PALM COMPUTING
4410 El Camino Real
Suite 108
Los Altos, CA 94002
415-949-9560
CIRCLE 78 ON FREE INFORMATION CARD

PANASONIC COMPANY
One Panasonic Way
Secaucus, NJ 07094
201-348-7000
CIRCLE 79 ON FREE INFORMATION CARD

PHILIPS INTERACTIVE MEDIA
11111 Santa Monica Blvd.
Los Angeles, CA 90025
310-444-6600
CIRCLE 100 ON FREE INFORMATION CARD

SAMSUNG ELECTRONICS AMERICA, INC.
105 Challenger Road
Ridgefield Park, NJ 07660
201-229-4000
CIRCLE 112 ON FREE INFORMATION CARD

SANYO FISHER (USA) CORPORATION
21350 Lassen Street
P. O. Box 2329
Chatsworth, CA 91311-2329
818-998-7322
CIRCLE 113 ON FREE INFORMATION CARD

SEGA OF AMERICA, INC.
130 Shoreline Drive
Redwood City, CA 94065
415-508-2800
CIRCLE 114 ON FREE INFORMATION CARD

SHARP ELECTRONICS CORPORATION
Sharp Plaza
Mahwah, NJ 07430-2135
201-529-8200
CIRCLE 115 ON FREE INFORMATION CARD

SIGMA DESIGNS, INC.
47900 Bayside Parkway
Fremont, CA 94538
510-770-0100
CIRCLE 146 ON FREE INFORMATION CARD

network fair—sometimes have trouble deciding what to watch. StarSight Telecast's on-screen, interactive program guide can help them decide, and help them tape programs on their VCR's. Transmitted over the vertical blanking interval of the Public Broadcasting System, StarSight already covers more than 86% of the country. The on-screen guide offers seven days of continually updated schedule information; program selection by title, theme, and

SONY ELECTRONICS, INC.
Consumer Products Group
Sony Drive
Park Ridge, NJ 07656
201-930-1000
CIRCLE 147 ON FREE INFORMATION CARD

STARSIGHT TELECAST
39650 Liberty Street
Third Floor
Southborough, MA 01772
508-460-1100
CIRCLE 148 ON FREE INFORMATION CARD

TANDY CORPORATION
700 One Tandy Way
Fort Worth, TX 76102
817-390-3592
CIRCLE 149 ON FREE INFORMATION CARD

TECHNICS
One Panasonic Way
Secaucus, NJ 07094
201-348-7000
CIRCLE 150 ON FREE INFORMATION CARD

THOMSON CONSUMER ELECTRONICS
6000 North Sherman Drive
MS27-214
Indianapolis, IN 46201
317-267-5000
CIRCLE 152 ON FREE INFORMATION CARD

THE IMAGINATION NETWORK
41486 Old Barn Way
P. O. Box 1550
Oakhurst, CA 93644
209-642-0888
CIRCLE 153 ON FREE INFORMATION CARD

THE 3DO COMPANY
600 Galveston Drive
Redwood City, CA 94063
415-261-3000
CIRCLE 154 ON FREE INFORMATION CARD

UNIDEN AMERICA CORPORATION
4700 Amon Carter Blvd.
Fort Worth, TX 76155
817-858-3300
CIRCLE 156 ON FREE INFORMATION CARD

UNITED STATES SATELLITE BROADCASTING (USSB)
3415 University Avenue
St. Paul/Minneapolis, MN 55114
612-645-4500
CIRCLE 157 ON FREE INFORMATION CARD

channel number; and one-button VCR recording capability.

At WCES 94, StarSight was shown in real products, including a stand-alone unit and StarSight-equipped televisions, VCR's, cable converters, and satellite decoders. The first company to offer video equipment that incorporates the technology is Zenith, which will introduce StarSight-equipped TV's and cable boxes this spring. Philips plans to market VCR's

with StarSight by the end of the year, and color TV's in 1995 under both the Philips and Magnavox brands. Samsung will begin producing StarSight-capable TV's, VCR's, and TVCR's by the end of this year, and Uniden America will offer StarSight on a new line of satellite receivers early in 1994. StarSight has also licensed the technology to Goldstar, General Instruments, Scientific Atlanta, and PCI Limited.

Should your StarSight on-screen schedule reveal two can't-miss programs aired at the same time, or shows airing when you won't be around to watch, relax. The system also provides a virtually fool-proof way to tape shows. The user simply selects a show from the on-screen menu and pushes a single button. StarSight automatically records the right show at the right time.

Even if you don't buy a StarSight-equipped device, taping has become easier thanks to Gemstar—the creator of VCR Plus+. Two new VCR Plus+ products now feature CallSet technology, which provides instant setup by telephone. One toll-free phone call programs the device for the consumer's exact model of VCR and cable box, the entire cable channel line up, and the correct date and time. VCR Plus+ with CallSet carries a suggested price of \$59.99. The VCR Plus+ Control Tower, the only universal remote control to offer the programming system, also offers CallSet. With CallSet, the universal remote can be continually upgraded by phone as you add new components to your home entertainment system. The Control Tower costs \$79.99.

Recognizing that people who can easily record programs on their VCR's are likely to end up with an unmanageable stack of tapes, Gemstar displayed another new technology at WCES 94. IndexPlus+ is an automatic indexing system that the company hopes to see in use this year. The system will use codes inserted into programming by the broadcasters to identify the taped material on each videocassette. VCR's equipped with Index Plus+ will display an on-screen list of all taped programs, and will allow the user to play back programs from that list in any order desired. The VCR will automatically fast-forward or rewind to the beginning of the selected program.

How will you find the time to watch your rapidly growing library of taped programs? Arista Technologies provides a form of "speed-watching" with their Commercial Brake. A hit at the show, the \$200 stand-alone device, which will be available by the time you read this, automatically senses the presence of commercial clusters and fast-forwards over them. That condenses a commercial-laden hour of television to its actual programming time of perhaps 40 minutes. It also relieves



Consumers who own the 18-inch dish and set-top receiver/decoder required for Thomson's Digital Satellite Service will be able to view up the 150 channels of programming.

commercials, it inserts a timing and identification code onto the videotape. During playback, the device is able to read that "playback map." When commercials are detected, the screen fades to blue and the VCR fast forwards through the break. The process is entirely automatic once the device is connected to a VCR and TV. For commercial-free playback, the viewer simply hits the VCR's play button. (In case someone actually wants to watch the commercials, a bypass switch is provided.)

Even if you no longer need your remote control to fast-forward through commercials, if you're like most of us, you still won't be able to live without one. The remote controls displayed at WCES 94 were smarter and, well, cooler than past models. For instance, Casio's Wrist Controller Model CMD-40 looks like a wrist watch but pulls triple duty as a learning universal remote and a calculator. The CMD-40 can operate a TV, VCR, and cable box. It is priced at \$129.95.

Let the games begin

Housed in three separate pavilions at WCES 94, video games attracted attention not only for their usual mind-boggling, raucous exhibits, but for some newswor-



Gemstar's VCR Plus+ with CallSet provides instant setup with one phone call.

the remote-control handler of the task of fast-forwarding manually (and then re-winding when the resumption of the show is missed), and allows parents to show their kids commercial-free programs.

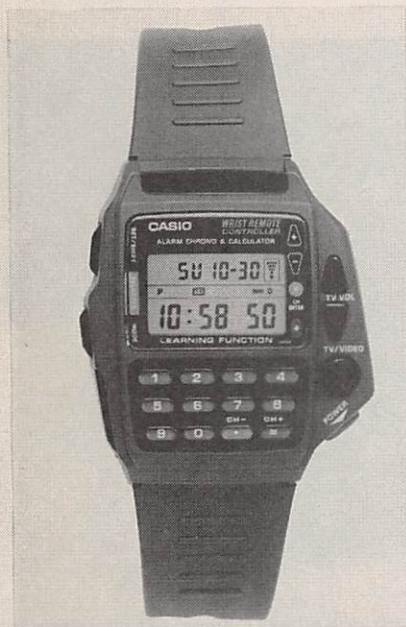
The Commercial Brake works by noting the indicators that appear at the beginning and end of each commercial, when sound and video are cut off momentarily. As it records the entire program, including



The Control Tower universal remote control from Gemstar features VCR Plus+ programming and CallSet setup.



The Commercial Brake from Arista removes unwanted commercial breaks upon playback of shows that you've taped on your VCR.



Casio's CMD-40 "Wrist Controller" is a watch, a calculator—and a "learning" universal remote control.

thy developments. Several new game systems, both cartridge- and CD-ROM-based, were on display. Reflecting the broadening of the hardware base, software manufacturers whose booths at previous shows fell under the wings of either Nintendo or Sega left the nest at WCES 94. Many displayed multi-platform titles in a pavilion separate from the hardware giants. And while gathered at the show, videogame developers and manufacturers held a series of meetings to discuss the voluntary implementation of an industry-wide ratings system—before the government mandates its own standards. No consensus was reached, however.

Meanwhile, new gaming hardware was introduced by Atari, Commodore, JVC,

and Sega. On the interactive-multimedia front, Panasonic displayed its real-life R.E.A.L. 3DO player. The 3DO Company provided updates on hardware and software developments. Philips' exhibited its CD-i full-motion-video (FMV) add-on cartridge and a host of new titles. Sigma Designs showed off a PC add-on card that will allow full-motion video to be shown on a computer monitor.

Atari—the company that pioneered the video-game industry with its 2600, displayed its new 64-bit Jaguar. The cartridge-based system is said to deliver unprecedented true-color graphics, CD-quality stereo sound, and fast action. Manufactured for Atari by IBM at its Charlotte, North Carolina plant, Jaguar will sell for about \$200, significantly less than many of its competitors' new products. As of January, 35 software companies had

signed licensing agreements with Atari.

Meanwhile, Commodore unveiled its Amiga CD³², a 32-bit CD-based games console that was introduced in Europe and in the United Kingdom last year. Built around the Amiga 4000 computer platform, the system contains special chips that have been "optimized for game and video performance." A true multimedia platform, the Amiga CD³² will also play audio CD's and CD+G (CD plus graphics) discs. A software upgrade is required to make the system compatible with Photo CD, and a \$250 module will enable it to play Video CD's and Philips' CD-i Digital Video releases. When the system is released in late February or early March, it will carry a suggested retail price of \$399, including two to four games. More than 100 titles should be available at introduction, double that by next Christmas.

Sega, which announced at WCES that its 16-bit Genesis system clearly outsold the Super Nintendo Entertainment System during the 1993 Christmas season, knows that 16-bit gaming still has quite a bit of life in it. The company also used the Consumer Electronics Show to launch its Genesis CDX entertainment system, the first to integrate 16-bit cartridge play and CD-ROM multimedia gaming. Genesis CDX is fully compatible with the entire library of nearly 500 available 16-bit Genesis games as well as dozens of Sega CD titles. It also serves as a portable CD player, measuring just 7.8×5.5×1.8 inches and weighing less than a pound and a half. It will be released in March at a suggested retail price of \$399, including three Sega CD titles: "Sonic CD," "Ecco the Dolphin," and a Sega Classics Arcade Collection CD that contains an assortment of games.

A newcomer to video-gaming—but not



Sega's Genesis CDX can play all cartridge-based Genesis games and all CD-ROM-based Sega CD titles.



JVC's X'EYE "multi-entertainment" system is compatible with audio CD's, CD+G's, CD-ROM's, Sega CD's, and Sega Genesis cartridges.

to digital technology—JVC introduced its X'EYE "multi-entertainment" system, capable of playing audio CD's, CD+G Karaoke, CD-ROM's, both Sega CD and Sega Genesis cartridges, and (with an optional ROM cartridge) Electronic Books. On-screen display menus make it easy to use in any mode. X'EYE will be available in April at a suggested list price of \$499, including three software titles: "Compton's Interactive Encyclopedia," a CD+G Karaoke disc, and a Sega CD game.

CD-i might be an old-timer in the world of interactive multimedia, but it isn't getting stodgy. In fact, Philips has seen dramatic sales increases in recent months due to a series of infomercials that aired on cable TV, and significantly lower prices. At WCES, Philips was showing its CDI220 player, which sells for about \$500, and the Magnavox CDI200 with a street price of about \$400. Both systems play audio CD's, Photo CD's, CD-i interactive discs, and—with the addition of the optional Full Motion Video Cartridge—Digital Video discs.

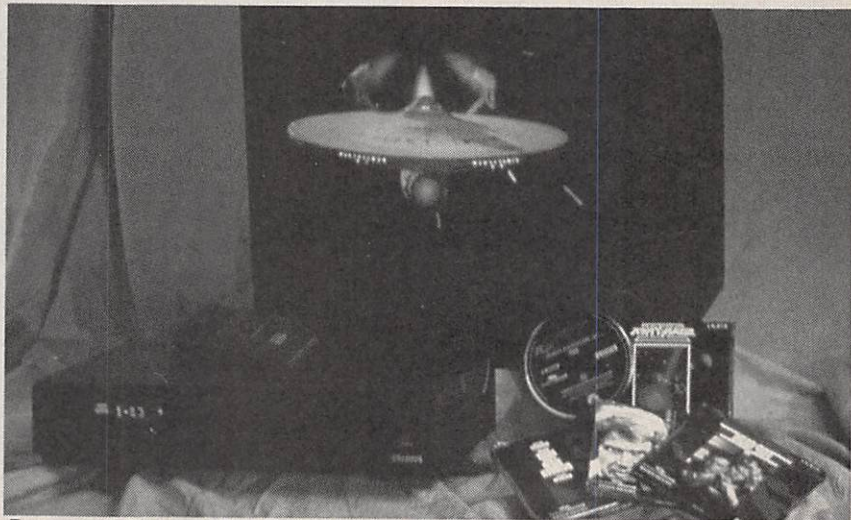
Several Digital Video interactive titles debuted at WCES, including "Caesar's World of Boxing," "Mad Dog McCree," "Microcosm," "Lilil Divil," and a couple of adult titles: "Joy of Sex" and "Playboy's Complete Massage." Recent and upcoming Digital Video movie titles include *Indecent Proposal*, *The Firm*, *Apocalypse Now*, and *Sliver*. Finally, Philips introduced a new infrared remote that will be shipped with the CDI200 and CDI220, replacing the "thumbstick" controller that came with older models, and the model 22er9017 "touchpad" remote for game playing that will retail for \$29.95.

Sigma Designs showed an add-on card for personal computers that allows full-motion, full-screen video to be displayed on the PC. It provides decompression for video recorded on disc with the MPEG 1 (Moving Picture Experts Group) compression standard. Primarily, the board is used to bring higher quality video to games and other multimedia titles. It will also, however, allow movies recorded in the Video CD standard, including CD-i Digital Video discs, to be played back on the PC.

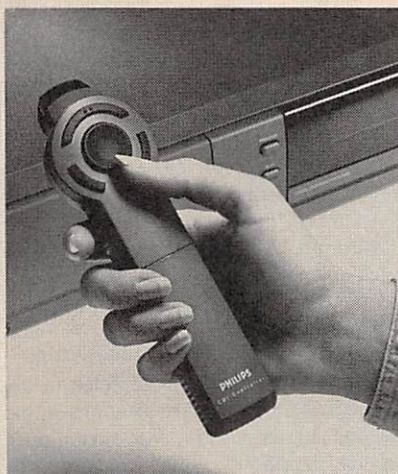
Most of the hype at the show could be found at the 3DO press conference, where company president Trip Hawkins—in a speech peppered with such phrases as "paradigm shift" and "digital synergy"—made a number of announcements. The 3DO Company is setting up its own rating system (although it will participate in the industry-wide games-ratings debates). An MPEG adaptor that will allow 3DO machines to play Video CD's



The addition of a Full Motion Video (FMV) cartridge allows Philips' CD-i machine to play Digital Video discs.



Paramount Pictures' Star Trek is one of several new Digital Video titles.



This slim infrared remote is now included with CD-i players from Philips and Magnavox.

will be available this spring. Technology advances, particularly the integration of the three ASIC's currently used to a single chip, will result in lower prices for 3DO players.

The most significant news on the 3DO hardware front, however, was that Sanyo, AT&T, and one as-yet-unnamed company will be introducing their own 3DO products this year. Sanyo had a sleek-looking prototype on display in their booth. AT&T expects to have three 3DO products available by the end of 1994: a conventional 3DO multiplayer, a player that will incorporate AT&T's VoiceSpan modem technology, and an add-on VoiceSpan adaptor.

AT&T, whose far-reaching visions for the future of telephone-based interactive multimedia are discussed below, is actively making a name for itself in the game-playing arena. VoiceSpan, which is currently used in AT&T's The Edge 16 product for Sega's Genesis system, allows voice and data to be transmitted simultaneously. That means that game players across the country can talk to each other as they play. AT&T, (along with partners General Atlantic Partners and Sierra Online), also owns The ImagiNation Network (INN), a nationwide entertainment network that offers real-time interaction between groups of people playing games or "chatting" via computer keyboards.

Consumer-electronic newcomers

Audio and video might form the backbone of the industry, but an increasing share of the consumer-electronics market—and the floor space at the Consumer Electronics Show—is occupied by computer-based products. The driving forces behind the upswing are home offices and multimedia. Both categories commanded a strong presence at the show.

PDA updates

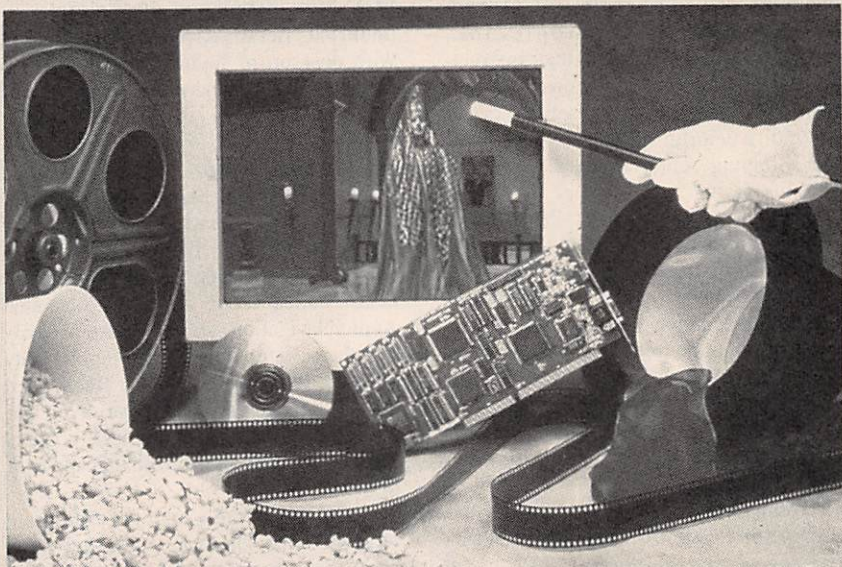
Because the entire March issue of

Gizmo was devoted to the first-generation PDA's, we won't provide any further technical background here, but their software and hardware add-ons demonstrated at the Winter Consumer Electronics Show deserve mention.

Most of the newly announced peripherals, particularly in terms of software, were for Apple's MessagePad and other Newton products. A new software publishing and distribution division of Apple, known as the StarCore Group, announced the release of 12 new titles for the MessagePad and plans to publish seven more. StarCore will also distribute titles from third-party software developers. First-quarter 1994 StarCore releases include "Money Magazine Financial Assistant," "The Economist World and Figures 1994," "Solitaire and Other Card Games," "Jig Saw Puzzle Strategy

Game," "Time Out Travel Guide," "DrawPad" (for architects and designers), and "Dell Crossword Puzzles. Third-party titles include "TaxPro," "Fodor's '94 Travel Manager," and "Silicon Casino." All applications are formatted either on PCMCIA cards that slide into the Newton MessagePad, or on Mac- or Windows-based floppy disks that can be transferred from a computer to a Newton PDA using the Newton Connection Kit. Prices will range from \$39 to \$100.

Also on display at the Apple booth was an assortment of communications devices. The Newton Messaging Card provides access MobileComm's wireless messaging service, which allows Newton users to receive postcard-length, alphanumeric pages. The Fax Modem Card, priced at about \$220, is a PCMCIA card that provides all the features of an external fax/



Sigma Designs' ReelMagic card allows PC's to deliver full-screen, full-motion video with CD-quality sound.



Panasonic was the first company to bring a "REAL" 3DO player to market.



An external fax/modem allows Sharp ExpertPad users to send and receive faxes.

modem card—and access to NewtonMail. Charging monthly and hourly fees, NewtonMail links Newton users to each other and to anyone on CompuServe, America Online, MCI Mail, AppleLink, SprintMail, EasyLink, and other Internet-accessible services. It also provides access to Apple's new interactive service called eWorld, a colorful on-line "community" for shopping, entertainment, research, and information.

Communications was also the story for Zoomer products from Casio and Tandy. PalmConnect (see Gizmo, April 1994) links the Zoomer to a PC for about \$129, and IntelliLink for Windows (\$99) will allow information from PC databases to be converted into a usable PDA format. Intuit is offering a transfer disk (\$95) that allows Zoomer users to transfer information from Pocket Quicken to Quicken 3.0 for Windows. Motorola's EMBARC wireless electronic-mail system is available for the Zoomer on PCMCIA NewsCards that carry a suggested retail price of \$249.

While new Zoomer software was notably missing from the show floor, Zoomer collaborators are putting public-domain software on America On-line. Zoomer users can download, at no charge, the names of restaurants in New York City, for instance, or the names, addresses, and phone numbers of the members of Congress.

Casio's president, John McDonald, speaking at a press reception, forecast increased PDA sales for 1994, despite a dramatic drop in sales a few weeks after the product's introduction last year. Blaming that slump on Apple's former CEO, John Sculley, who raised the media's expectations for PDA's before the Newton was even released, McDonald said, "The whole PDA category probably got mired in John Sculley's over-promising and under-delivering." Casio remains optimistic about the future of PDA's, however, and announced plans to introduce two new Zoomers at the Summer Consumer Electronics Show in June.

CD-ROM-inations

As evidenced by the recent developments in the gaming world, CD-ROM truly has become a mass-market consumer commodity. Multimedia PC's—big sellers last Christmas season—were on display at several computer-company booths. Even Intel set up "The Adventure Inside," a theme-park-style exhibit that included a "clean room" microprocessor fabrication plant, a walk-through mock-up of a giant computer, and a most uninformative trip through a Pentium processor chip. Finally, visitors got to play with the latest computer games and educational programs on more than 40 Pentium-based PC's.

MediaVision displayed the first personal CD-ROM player for Macintosh- and IBM-compatible computers. Billed as "Multimedia Unplugged," the Reno is a compact, light-weight, double-speed CD-ROM drive that runs on either nickel-cadmium batteries or AC power. It can be used with desktop or laptop computers, and functions as a stand-alone portable CD player.

On the road again

CD-ROM is also being put to use in the AudioNav vehicle navigation system, premiered at WCES by Eclipse Mobile Electronics and Amerigon. The system, which is also called VAAN for Voice-Activated Audio Navigation, allows drivers to easily find their destination in an unfamiliar city without looking at a map. Because it doesn't depend on global positioning satellites and the associated wheel-mounted sensors, the system is affordable and easy to install.

AudioNav is the electronic equivalent of having a person in the passenger's seat giving you directions. The system's CD-ROM drive, which is connected via the car's CD player, reads data discs produced by Etak. Those discs contain maps and other pertinent information for a certain city. Once the data is loaded, normal CD play is possible. The rest of the system consists of the speaker and microphone required for verbal interaction.

We took a test drive around Las Vegas in a VAAN-equipped RV. To get directions, the driver vocally spelled out the starting position, using either a landmark, an address, or an intersection. In our case, it was the Las Vegas Convention Center. Next, the destination (a house address a few miles away) was indicated in the same manner. AudioNav first let us know how far the destination was and approximately how long it would take to get there. It then provided street-by-street directions, such as: Take Convention Center Drive east for less than one block and make a left turn at the light. Go less than one block to Pacific Street and make a left. The next instruction might be "Travel three miles on Pacific

Street and then make a right turn onto Atlantic." If the first route is blocked by traffic or road closures, AudioNav can provide an alternate path on request.

The user can talk in a normal speaking voice, and AudioNav can even recognize regional and ethnic accents. Because the system will first be released in southern California, AudioNav was "taught" to pick up on Hispanic accents, for instance. In our test drive, however, it had some difficulty with "New Yawk-ese"—we doubt it could find "thoity-toid and toid."

The VAAN system is expected to become available in select locations in the second quarter of 1994, with a retail price of less than \$600. Future enhancements are expected to include a traveler's directory that will make it easy to locate gas stations, restaurants, lodging, etc.

The Great Beyond

Those of us who still have a hard time getting around today's concrete highways and byways—not to mention those who still have trouble operating today's consumer-electronics gear—might not even want to contemplate navigating tomorrow's information superhighway. But the fact is, it's coming. It's hard to open a newspaper these days without reading about it—and you certainly couldn't get through the Winter Consumer Electronics Show without hearing about it.

In fact, the show was opened with a speech from Robert Kavner, AT&T executive VP and CEO of Multimedia Products, in which he addressed the benefits that the consumer-electronics industry could reap—and the pitfalls it could face—in the development of interactive multimedia communications.

Kavner outlined two potential scenarios: the open, competitive, intelligent network being espoused by AT&T, and a closed-access, non-competitive, "gatekeeping" model that would resemble today's cable-TV industry (or the phone company of a decade ago). While it would be hard to argue with his easy-to-use, free-speech, free-trade, and fun telephone-system model, keep in mind that the cable companies were not on hand for a rebuttal.

AT&T envisions that the information superhighway will be built around its PersonaLink Services. The new network service will allow everyone in the "electronic community" to purchase products and services, work, and play. "Intelligent assistants"—customizable software that represents a user's interests—by acting as highly intuitive, trainable personal secretaries, screening and sorting e-mail, scheduling appointments, etc. Intelligent assistants are a key part of making the service useful and appealing to consumers and business users alike.

For more information on any product in this section, circle the appropriate number on the Free Information Card.

WCES WISH LIST

Road Radio

Personal portable stereos have revolutionized the way we listen to music—and where we listen. Although they can be used *almost* anywhere, anyone who has ever been pulled over while using a headphone stereo on a bicycle can tell you that there are exceptions. *Emerson Radio Corporation* (9 Entin Road, Parsippany, NJ 07954) has a safe substitute: the *AR2515* AM/FM bicycle radio. The weather-resistant radio is intended to be mounted on the handlebars. It includes an electronic horn and a front-mounted reflector. The radio can be detached from its mount easily, so the chance of theft is reduced. Price: \$29.95.

CIRCLE 116 ON FREE INFORMATION CARD

Cordless Mailbox

Parents who are tired of listening to their teens' seemingly endless phone messages on the family answering machine might appreciate the *Cobra* (6500 West Cortland Street, Chicago, IL 60635) *Intenna model AN-8591* cordless phone/answering machine with four "personal mailboxes." The all-digital answering device prompts callers to enter a user's mailbox code so that they can leave a private message. Alternately, users can leave their messages in the system's general mailbox. Like other *Cobra* cordless telephone products, the device incorporates the exclusive *Intenna* technology, which eliminates the external antennas on both the base and handset pieces. Price: \$249.95.

CIRCLE 117 ON FREE INFORMATION CARD

Satellite Car Security

In an effort to combat car theft, *Audiovox Corp.* (150 Marcus Blvd., Hauppauge, NY 11788) has introduced the *Posse*. The device uses a satellite and a microprocessor to provide security, including a way to recover an automobile after a car-jacking. In such a situation, the driver would give up the car without resisting. He would then phone the *Posse* Communications Center via a toll-free number to report the theft. The Communications Center would then send out a signal to activate the device. Once the signal is received, the car's horn begins to sound and the headlights begin to flash. An optional siren can also be activated. When the thief turns off the engine, the car can't be started. The *Posse* can also be used by absent-minded drivers who lock their keys in the car. A call to the Communications Center can unlock the door (if the car is equipped with power locks.) The *Posse* can even start the car. Imagine using an in-flight telephone to call the service as your plane is approaching for a landing in the middle of winter. Price: N/A.

CIRCLE 118 ON FREE INFORMATION CARD

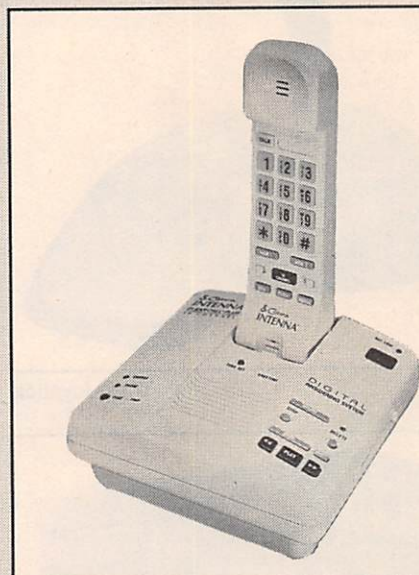
In the Right Key

Anyone, regardless of musical ability, can play the *Key*, an "intelligent interactive controller" from *Lonestar Technologies* (920 South Oyster Bay Road, Hicksville, NY 11801-3518) that acts like a musical instrument. The *Key* looks something like a guitar, but the neck is outfitted with a keyboard, and the strings are replaced with "strummer veins." The *Key* can be played by itself as a synthesizer. Its real advantage is its ability to accept digital information from specially encoded sources. An encoded music video, for example, allows users to play along in the right key. The intelligence in the *Key* makes sure that everything sounds good. The *Key* conforms to the General MIDI standard, so it can be used with a large library of existing MIDI devices and tracks. Price: \$400.

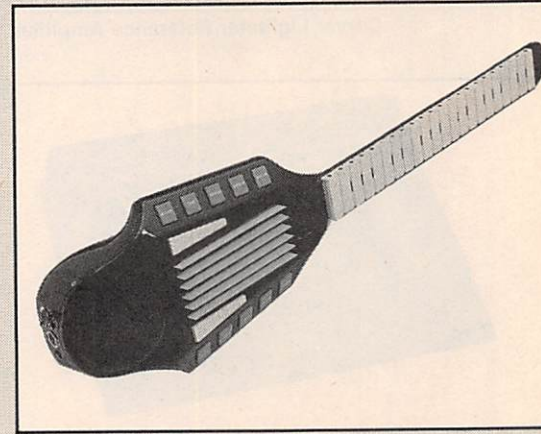
CIRCLE 121 ON FREE INFORMATION CARD



Emerson AM/FM Bicycle Radio



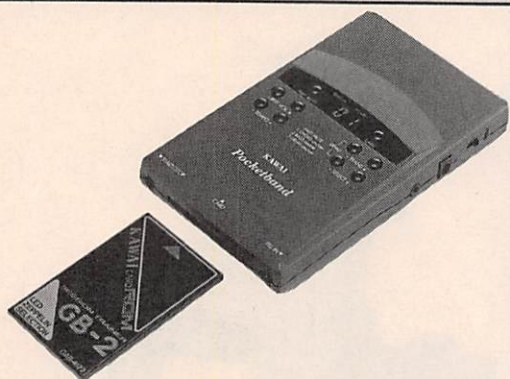
Cobra Cordless Phone/Answering System



Lonestar's The Key

WCES WISH LIST

For more information on any product in this section, circle the appropriate number on the Free Information Card.



Kawai Pocketband Rehearsal Tool

One-Pocket Band

Called the "world's smallest rehearsal tool," the *Pocketband* from Kawai America (2055 East University Drive, Compton, CA 90220) allows practicing musicians to play with accompaniment. The device weighs less than one pound and measures about 4 x 6 3/4 inches and is intended to hook onto a belt much like a personal portable stereo. It offers several advantages over cassette practice tapes. Players can change the tempo of the music without changing its pitch. Or they can change the key without changing the tempo. *Pocketband* comes with 20 built-in rhythms from blues to rock to big-band. Song Cards, which contain arrangements of popular music in various styles are also available. Price: \$199.

CIRCLE 122 ON FREE INFORMATION CARD

Taking Control

Owners of Sega Genesis and Super Nintendo systems will appreciate a *Multi-Function* joystick from Triax Technologies (11 Computer Drive West, Albany, NY 12205). According to Triax, the new "top-of-the-line arcade-style joystick is more like a new game system than a new controller" because it offers capabilities never available before. When games are written to take advantage of the controller, players will be able to vary the speed of on-screen characters or objects, and move them in any direction—even in the "z" direction, into or out from the background. Major companies, including Electronics Arts, Virgin, and Sunsoft are producing games that take advantage of the joystick. Price: \$49.95.

CIRCLE 123 ON FREE INFORMATION CARD

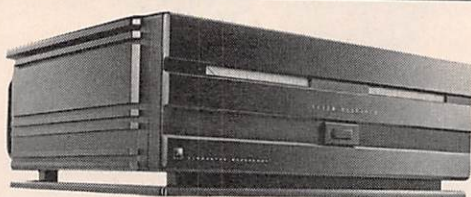


Triax Joystick

Lightstar

A new amplifier from Carver Research (20121 48th Ave. West, Lynnwood, WA 98036) is said to represent "a major departure from conventional amplifier design." The *Lightstar Reference* amplifier uses such innovations as a precision digital transformer (whatever that is) and a reactive current-return path architecture that is said to achieve total independence from the effects of reactive loudspeaker loads. According to Carver, traditional amplifiers tend to "fight" the complex reactive loads imposed by loudspeakers. The *Lightstar* amplifier is unaffected by the load because it recycles reactive energy back into the power supply so as not to disturb the amplified signal. If the digital transformer and peaceful loudspeaker relations don't impress you, perhaps the amplifier's looks will. Innovation usually doesn't come cheap; the *Lightstar Reference* doesn't either. Price: \$3000.

CIRCLE 124 ON FREE INFORMATION CARD



Carver Lightstar Reference Amplifier

Video Magic

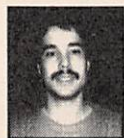
Consumers will be able to turn their amateurish camcorder shots into professional-looking video with the *Digital Video Mixer* from Videonics (1370 Dell Avenue, Campbell, CA 95008). The device is virtually an all-in-one video production studio. It allows videographers to mix multiple video sources seamlessly thanks to its dual-field timebase corrector. The device offers a host of broadcast-quality special effects. For example, one scene can dissolve into another. A chroma key is also offered, so that backgrounds can be replaced. (That is the effect used to change weather maps behind the on-air weather forecasters.) Over 200 special effects—including mosaic, strobe, freeze, and zoom—can be added. A built-in audio mixer allows users to combine sound from video sources or separate sound sources. Price: \$1199.

CIRCLE 125 ON FREE INFORMATION CARD



Videonics Digital Video Mixer

Just like these Fully Trained Electronics Professionals



"Thanks to CIE I have tripled my previous salary, and I am now in a challenging and rewarding new field where only the sky is the limit."

Daniel Wade Reynolds
Industrial Electrician
Ore-Ida Foods



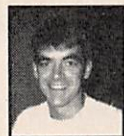
"CIE was recommended to me by my boss. It was appealing since I could study at my own pace at home and during business travel."

Dan Parks
Marketing Manager/Consumer Products
Analog Devices, Inc.



"I loved the flexibility CIE offered. It was the only way I could continue both school and my demanding job."

Britt A. Hanks
Director of Engineering
Petroleum Helicopters, Inc.



"I liked the way the school was set up with laboratory assignments to enforce conceptual learning. The thing which impressed me the most about CIE's curriculum is the way they show application for all the theory that is presented."

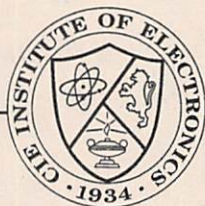
Daniel N. Parkman
Missile Electro-Mechanical Technician
U.S. Air Force



"Completing the course gave me the ability to efficiently troubleshoot modern microprocessor based audio and video systems and enjoy a sense of job security."

Tony Reynolds
Service Manager/Technician
Threshold Audio & Video

Graduate with an Associate Degree from CIE!



CIE is the best educational value you can receive if you want to learn about electronics, and earn a good income with that knowledge. CIE's reputation as the world leader in home study electronics is based solely on the success of our graduates. And we've earned our reputation with an unconditional commitment to provide our students with the very best electronics training.

Just ask any of the 150,000-plus graduates of the Cleveland Institute of Electronics who are working in high-paying positions with aerospace, computer, medical, automotive and communications firms throughout the world. They'll tell you success didn't come easy...but it did come...thanks to their CIE training. And today, a career in electronics offers more rewards than ever before.

CIE'S COMMITTED TO BEING THE BEST...IN ONE AREA...ELECTRONICS.

CIE isn't another be-everything-to-everyone school. CIE teaches only one subject and we believe we're the best at what we do. Also, CIE is accredited by the National Home Study Council. And with more than 1,000 graduates each year, we're the largest home study school specializing exclusively in electronics. CIE has been training career-minded students for nearly sixty years and we're the best at our subject...

ELECTRONICS...
IT'S THE ONLY SUBJECT
WE TEACH!

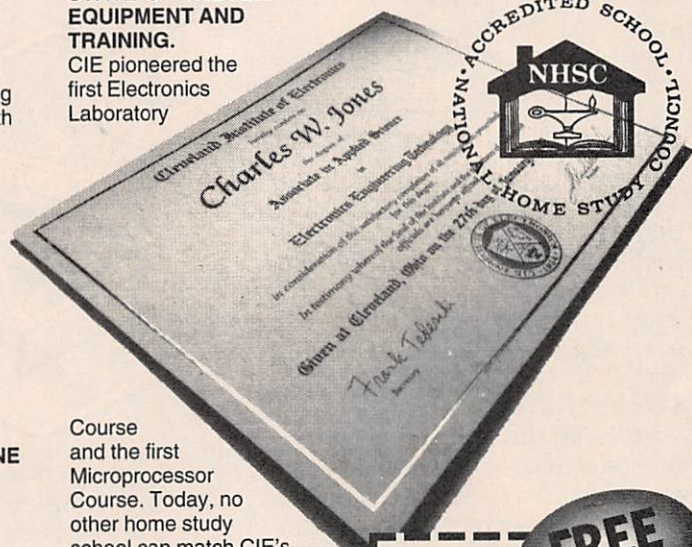
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Beyond Ohm's Law

We present an introduction to Kirchoff's Laws, the superposition theorem, and Thevenin's and Norton's equivalents.

BY PAUL COXWELL

Ohm's Law is so fundamental to electronics that it is second nature to all but the very latest newcomer to the field. Ohm's Law can be applied to calculate an unknown quantity for a single component, a section of a circuit, or the entire circuit, no matter how complex.

There are circuits, however, that cannot be easily analyzed using Ohm's Law alone; but they can be handled by using additional methods of analysis. We will examine four such analysis tools: Kirchoff's Laws, the superposition theorem, Thevenin's Theorem, and Norton's Theorem using resistive DC circuits as examples.

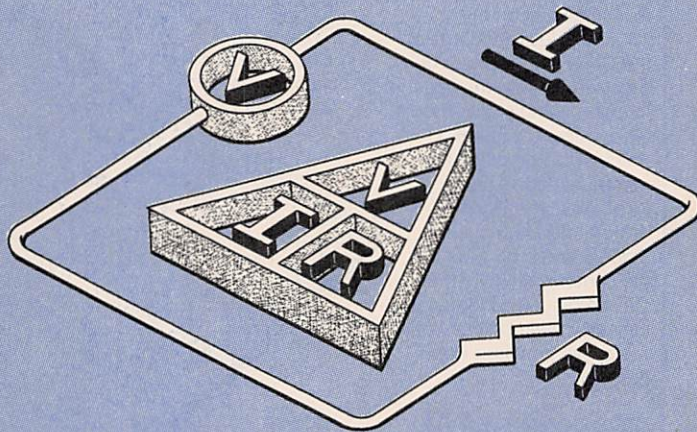
Kirchoff's Laws.

Kirchoff's First Law states

that the sum of the currents flowing into a junction must equal the sum of the currents flowing out of that junction. Refer to Fig. 1, in which we have a simple parallel circuit. When given the values of R1, R2, and the source voltage, the application of Ohm's Law shows that I₁ is 4 amps and I₂ is 2 amps. One way to determine the total current drawn from the battery would be to calculate the equivalent resistance of R1 and R2 in parallel and then apply Ohm's Law to the answer; that yields figures of 2 ohms and 6 amps.

The other way to get the answer is to apply Kirchoff's Law at point X or point Y. The total current (I_t) flowing into point X must equal the sum of the two branch currents I₁ and I₂, giving 6 amps. At point Y, the branch currents recombine, again satisfying the Law. The concept, like Ohm's Law, is taken almost for granted, and is often performed without conscious thought of Kirchoff's Laws.

Kirchoff's Second Law states that the sum of the voltage drops in a circuit must equal the sum of the voltage rises, or sources. In the series circuit of Fig. 2A, the total resistance is 24 ohms, giving a current of 0.5 amps. Ohm's Law can be used to determine the voltage dropped across R1; the answer is 9 volts. To comply with Kirchoff's



Law, the voltage dropped across R2 must, therefore, be 3 volts. Once again, this principle is so simple that we perform calculations of this type almost subconsciously.

The addition of a second voltage source, as in Fig. 2B, causes no problems; we just add the two battery voltages together:

$$12V + 12V = V_{R1} + V_{R2}$$

Even when the two batteries are separated, as in Fig. 2C, it is still a simple matter to add the voltage rises and voltage drops, since all the components still form a simple series circuit. The results are the same as for the previous example.

Figure 3 shows a more complicated situation. Suppose that we need to calculate the current that flows through each of the three resistors. The two completely separate voltage sources make the task impossible using just Ohm's Law. To solve the problem requires the use of Kirchoff's

Second Law and a little high-school math in the form of simultaneous equations.

Remember that Kirchoff's Law can be applied to any closed loop of a circuit. If we assume that a voltage source is a positive quantity and that a voltage drop across a resistor is a negative quantity, then the algebraic sum for any closed loop must be zero. There are two complete current loops in the circuit shown. Current I₁ flows through B1, R3, and R1, while I₂ flows through B2, R2, and R3. Note that the current through R3 is the combined current of both I₁ and I₂.

The voltage drop across each resistor can be determined by Ohm's Law. For R1, for example, the voltage is equal to the value of R1 multiplied by I₁. Starting at the positive pole of B1, trace counterclockwise around the first loop, adding each voltage to the equation as it is encountered. That gives:

$$B1 - R3(I_1 + I_2) - R1I_1 = 0$$

Notice that because both I₁ and I₂ flow through R3, we must use the sum of these two currents to calculate the voltage drop across the resistor. The second loop is written in a similar way, starting at the positive pole of B2 and tracing clockwise around the circuit, giving:

$$B2 - R2I_2 - R3(I_1 + I_2) = 0$$

Next, multiply out the bracketed section of each equation and substitute the known values for B1, B2, and the three resistors:

$$21 - 6I_1 - 6I_2 - 3I_1 = 0$$

Group all the I₁ and I₂ terms together in each equation, and move the con-

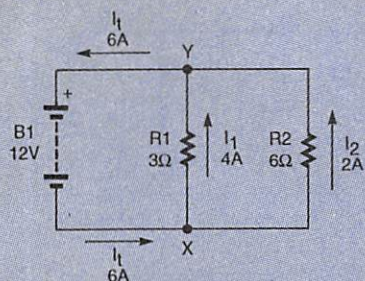


Fig. 1. Kirchhoff's First Law states that the sum of the currents flowing into a junction must equal the sum of the currents leaving that junction.

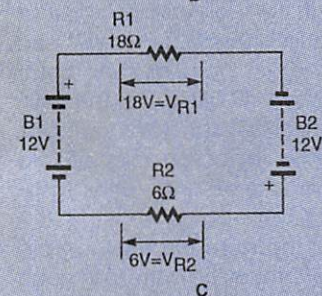
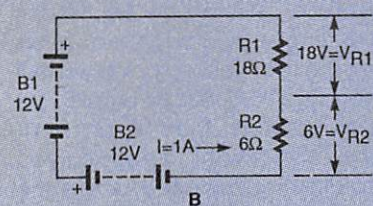
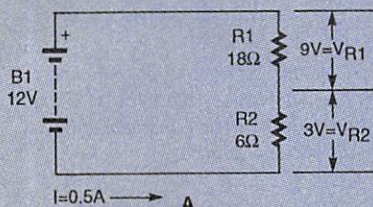


Fig. 2. Kirchhoff's Second Law is demonstrated by this simple series circuit.

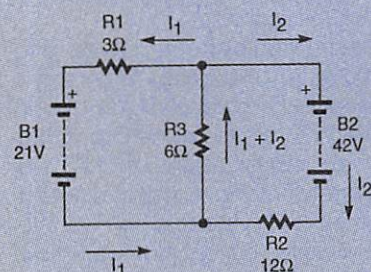


Fig. 3. Kirchhoff and simultaneous equations help solve this problem.

starts (the battery voltages) to the opposite side of the equals sign:

$$\begin{aligned} -9I_1 - 6I_2 &= -21 \text{ (Eq. 1)} \\ -6I_1 - 18I_2 &= -42 \text{ (Eq. 2)} \end{aligned}$$

At this point, we need to cancel out either I_1 or I_2 in order to get the result

for one loop. You may multiply both sides of an equation by any factor, so multiplying Eq. 1 by -3 gives:

$$27I_1 + 18I_2 = 63$$

Adding that to Eq. 2 (allowing the I_2 terms to cancel) yields:

$$21I_1 = 21$$

Current I_1 , therefore, is equal to 1 amp.

The value of I_2 can be determined by inserting the now-known value of I_1 in any convenient equation. Substituting in Eq. 1 and simplifying we get:

$$\begin{aligned} -9 - 6I_2 &= -21 \\ -6I_2 &= -21 + 9 \\ I_2 &= 2A \end{aligned}$$

Returning to the problem of calculating the current through each resistor, we have already worked out the currents through R_1 and R_2 . The current through R_3 is equal to sum of I_1 and I_2 (by Kirchhoff's First Law), which is 3 amps.

If the value for a current is negative, then the direction of current is opposite to that that was assumed when the problem was started. Although the solution may at first look somewhat complicated, once the first two equations have been derived from the circuit, the rest of the problem is purely mathematical.

Superposition Theorem. Unlike the approach just described which analyzes the effects of voltage sources acting simultaneously, the superposition theorem allows us to examine the effect of each source separately and then combine the results. The theorem offers a slightly less mathematical approach to circuit problems, and is probably preferred by people who don't like algebra.

Refer back to the circuit of Fig. 3. To observe the effect of battery B_1 alone, we must remove the second source of power. Taking B_2 out of the circuit gives the diagram shown in Fig. 4A. Notice that the points that previously connected the poles of B_2 have been joined together to keep the loop complete. That is because it is assumed that the internal resistance of the battery is so low as to be of no consequence. However, when using the superposition theorem with voltage sources that have appreciable internal resistance, you should use an equivalent resistance instead of a direct short-circuit.

The current flowing through each part of the circuit in Fig. 4A can now be calculated quite easily, since there is only one power source and a simple series-parallel resistor network. The combined resistance of R_2 and R_3 is 4 ohms, giving a total circuit resistance of 7 ohms and a total current through R_1 and B_1 of 3 amps. That current is split at the parallel resistors, with 1 amp passing through R_2 and 2 amps through R_3 .

Next, we must perform the same procedure with the second voltage source. Figure 4B shows B_2 returned to its correct place in the circuit and B_1 temporarily removed. The parallel resistors R_1 and R_3 have an equivalent resistance of 2 ohms, so the total circuit resistance is 14 ohms and the total current is 3 amps. Resistor R_1 carries 2 amps of that current, with R_3 carrying the remaining 1A, as shown.

The final step is to combine the two sets of values you have calculated. Taking R_3 first, we have 2 amps of current from battery B_1 and 1 amp from B_2 . At this stage you must be very careful to observe the direction of each current. In this case, both arrows are pointing in the same direction, so the total current through R_3 is 3 amps, as shown in Fig. 4C. (Note that the arrows show the direction of electron

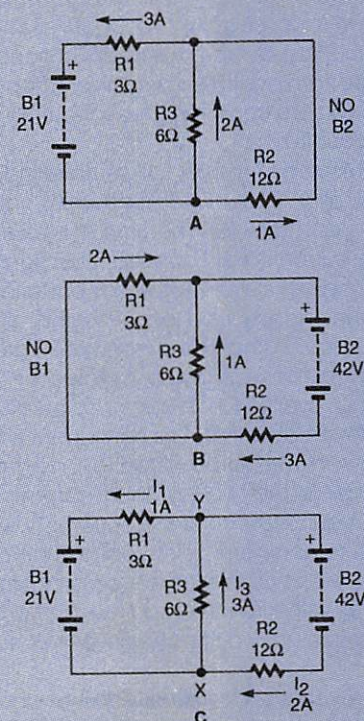


Fig. 4. The superposition theorem examines each voltage source separately and then combines the results.

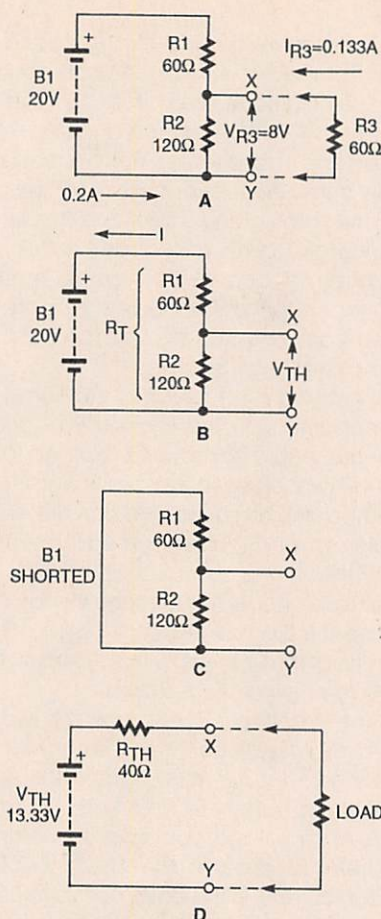


Fig. 5. Thevenin's Theorem allows a circuit to be reduced to a single voltage source and series resistance.

flow, from negative to positive. You could just as easily use conventional flow, from positive to negative, so long as you are consistent throughout your calculations.)

Moving to resistor R1, we have individual currents of 3 amps from B1 and 2 amps from B2. This time, however, the currents are in opposite directions, so the net current with both batteries connected will be equal to the difference, 1 amp. The currents at R2 are also opposing, giving a value of 2 amps overall. Once again, be careful with the polarities: The net current will flow in the same direction as the larger of the two individual currents.

A quick check of the currents flowing to and from points X and Y in Fig. 4C will confirm that the circuit complies with Kirchhoff's First Law. That is a convenient way to check your work.

Thevenin's Theorem. Another analytical tool which can simplify certain tasks is Thevenin's Theorem. It states that any combination of resistances

and voltage sources, between any two points in the network, can be replaced by an equivalent circuit consisting of just one voltage source and a series resistance.

Let's take an example to show how Thevenin's Theorem can simplify a problem. Figure 5A shows a simple voltage divider with an output at points X and Y. Let's say that you want to connect various loads (R3) to that output and determine the current and voltage for each load.

The "regular" way to perform the calculation would be to assume a known load, say 60 ohms. Resistors R2 and R3 in parallel give an equivalent resistance of 40 ohms. The overall circuit resistance, is therefore 100 ohms, giving a current of 0.2 amps through R1 and B1, and a drop of 12 volts across R1. That leaves 8 volts across the load, with a current of 0.133 amp. Each of those steps would have to be performed again for each load of interest since all the current and voltage values would change.

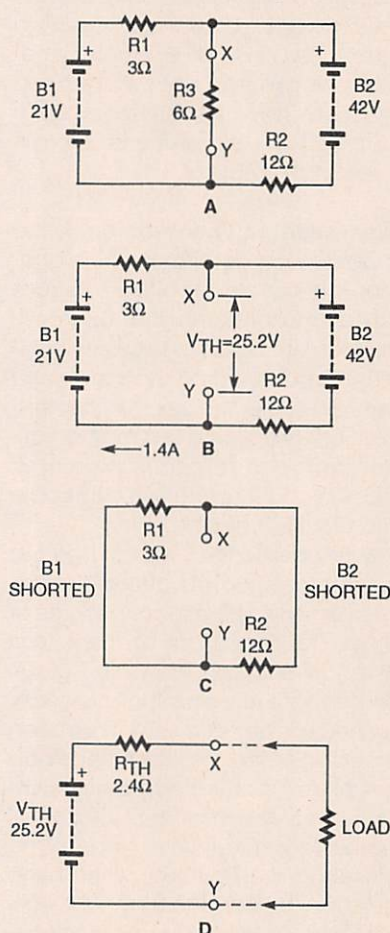


Fig. 6. The benefits of Thevenin's Theorem become clear when applied to a more complex circuit.

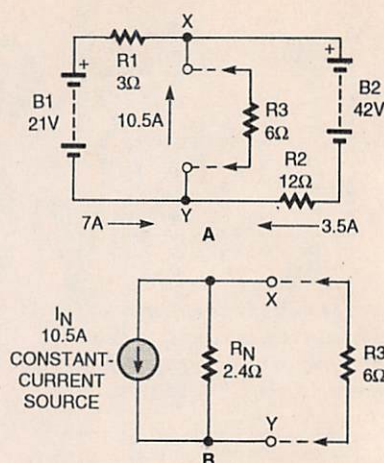


Fig. 7. Norton's Theorem is somewhat similar to Thevenin's, but uses a constant-current source instead of a constant-voltage source.

Two steps are required to convert a network to its Thevenin equivalent. First, determine what voltage appears across the two required points without the load (see Fig. 5B). By simple voltage-divider math, that Thevenin voltage is 13.33 volts. Second, you calculate the resistance across the two points with all voltage sources short-circuited (Fig. 5C). Since R1 and R2 are then in parallel, their combined value is 40 ohms. The Thevenin equivalent circuit can now be drawn, applying the values you calculated to a voltage source and series resistance (Fig. 5D).

You can now use the Thevenin circuit to determine the current through and voltage across each load resistor that you connect to X and Y. The calculations for each load have been reduced to those for a simple two-resistor series circuit.

Far greater benefit can be obtained when Thevenin's Theorem is applied to a more complex circuit. Figure 6A shows the same circuit that was used earlier. Assume that R3 is a load that may have many different values of resistance and you want to determine the current that would flow through each. To perform each calculation with simultaneous equations or the superposition theorem would be lengthy.

Fortunately, we can use Thevenin's Theorem to greatly simplify the task. With R3 removed, the circuit becomes a series network with two opposing voltage sources (see Fig. 6B). It is rela-

(Continued on page 95)

Build a Remote-Control Relay Station

A one-evening project can help your remotes' signals turn corners, or boost their power for well-lit or extra-long rooms.

BY JOHN YACONO

I really think remotes are great. They give you the freedom to control a battery of entertainment units and other equipment from a single location. To some that's a support for laziness, but to me that freedom makes it easier to switch to more enriching programming if what I'm watching or hearing isn't worth the time.

Sometimes though, that freedom extracts an extra price. For example, you might have to draw a blind to keep sunlight from interfering with a remote (a problem in one unfortunately shaped room in my house). Or perhaps you might have to place a couch or easy chair conspicuously in the middle of a very large media room (a problem for a friend of mine). You are also confined to the room containing the equipment—that's hardly full freedom.

Of course, a remote booster may solve the first two problems, but with three provisos: you must deal with added bulk on the remote, the booster must be strong enough to work from the viewing position, and you must swap the booster between remotes or buy more than one. So a booster may be unsightly, tiring to hold, still inadequate for some rooms, and either a pain or expensive for multi-remote use. It is also unlikely to bounce signals around corners.

An alternative is to use an RF universal remote. However, you must find one that is "universal" enough for all your equipment. Furthermore, they

tend to lack buttons for most equipment's special features (commercial skip, alternate channels, a jog shuttle, etc.) which might have played a part in your original purchase decision. Not to mention they're down-right frightening to non-technical family members (believe me, I know)! Besides, most folks are looking to reduce the amount of RF around the home due to the ELF health scare (see "Electromagnetic Fields and Your Health," *Popular Electronics*, March, 1993).

A third possibility is to use an IR-to-RF relay station. They allow you to use your own remotes from any location, but again, only provided your not concerned about RF radiation. Oh yes, and you must plunk-down around \$100 (almost the cost of a play-only VCR with its own remote).

I didn't like any of the mentioned alternatives, so I built the *Remote-Control Relay Station*. It looks for IR signals, demodulates them (to ensure they're from a remote), then re-modulates and broadcasts them at high-power. It can be placed anywhere between the remote user and the equipment (say on a coffee table) to act as an unobtrusive booster, or in a strategic corner to rebroadcast signals from a user down a hallway. Also, the units are so inexpensive to build, it would be more economical to build several to relay signals between rooms than to buy an RF remote or IR-to-RF relay station.

To add to its charm, the circuit is



simple to build, and it's a good project for beginners. Its components are readily available, and no special PC board is required. The unit's simplicity is mainly due to the use of an all-in-one IR-demodulator module. Let's discuss its operation and function first.

Demodulating IR. Remote controls basically transmit serial digital information. They encode digital pulses on an IR carrier by turning the carrier on and off. That is known as burst-style data transmission. To see what all that means, take a look at Fig. 1. The top-most waveform represents a series of digital pulses that need to be transmitted by the remote control one at a time. The remote control transmits them by turning on a 40-kHz oscillator for the duration of each pulse. The output of the oscillator (represented by the bottom plot) drives an infrared emitter that pumps those 40-kHz pulses into the room as IR.

As mentioned earlier, the Remote-Control Relay Station uses a special module to detect and convert those 40-kHz IR pulses back into the digital pulses they represent. It is called the GPIU52X infrared-detector module. To help explain its operation, I have broken it down into functional blocks that are shown in Fig. 2. Refer to that figure as I explain further.

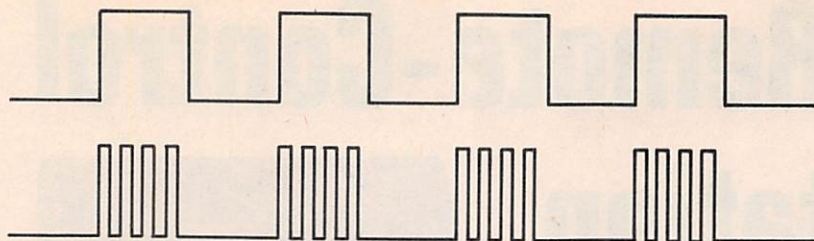


Fig. 1. Some data pulses that must be encoded and transmitted by a remote are shown at the top. The data is transmitted as a series of bursts of infrared as shown in the bottom plot.

All IR is received by the module via an IR photodiode. The diode is operated in its reverse-bias mode. The amount of reverse-bias current it permits depends on the intensity of the received infrared light.

The fluctuations in the reverse-bias current are then amplified by a high-gain stage. The output of the amplifier is then "limited" by the next stage. The limiter chops the extreme highs and lows off the amplified signal and the result is a quasi-digital pulse train.

The simplified wave then passes through a bandwidth filter. It has its center frequency at 40 kHz and a bandwidth of ± 4 kHz. The filter cuts out more noise and also prevents sources of infrared operating at the wrong frequency (such as the light bulb) from causing false activation. The filtered signal is then rectified for further processing.

At that point, the circuit has effectively retrieved the 40-kHz remote carrier. The reproduced carrier is then integrated. What that means is that it is

sent through a filter that responds slowly to the changing signal—too slowly to follow the 40-kHz carrier pulses, but quick enough to rise and fall significantly with each burst and pause between bursts, respectively.

The next stage takes advantage of those characteristics. It is called an "inverting Schmitt trigger." It will not go low unless the filter's output signal surpasses a certain amplitude, and will not go high again until the signal drops below a certain minimum. Thus the Schmitt trigger only responds to large changes in the filter's output (caused by bursts and pauses) and ignores small changes (caused by the 40-kHz carrier to which the filter can't respond quickly). The Schmitt-trigger's output is thus low when a 40-kHz burst

PARTS LIST FOR THE RELAY STATION

SEMICONDUCTORS

- U1—555 oscillator/timer, integrated circuit
- Q1—2N2222 general-purpose NPN silicon transistor
- Q2—2N3906 general-purpose PNP silicon transistor
- LED1—LED3—SY-IR53L IR-light-emitting diode
- MOD1—GPIU52X IR detector/demodulator module (Radio Shack No. 276-137)
- D1—D2—2.4-volt, 500-mW Zener diode
- D3—1N914 general-purpose small-signal silicon diode

RESISTORS

(All resistors are $\frac{1}{4}$ -watt, 5% units unless otherwise indicated.)

- R1, R2—18,200-ohm, $\frac{1}{4}$ -watt, 1%
- R3—47-ohm
- R4—100,000-ohm
- R5, R6—10,000-ohm

ADDITIONAL PARTS AND MATERIALS

- C1—0.001- μ F, NPO ceramic-disc capacitor
- C2—0.1- μ F bypass capacitor
- B1—9-volt transistor-radio battery
- S1—SPST on/off switch
- Project box, double-sided foam, perf-board, wire, solder, etc.

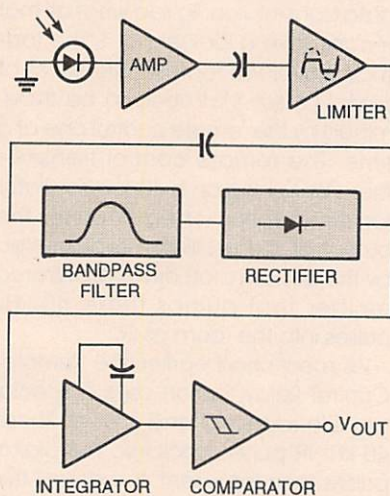


Fig. 2. The module stages look something like this. Together they process infrared light to extract any pertinent waveform and then demodulate it.

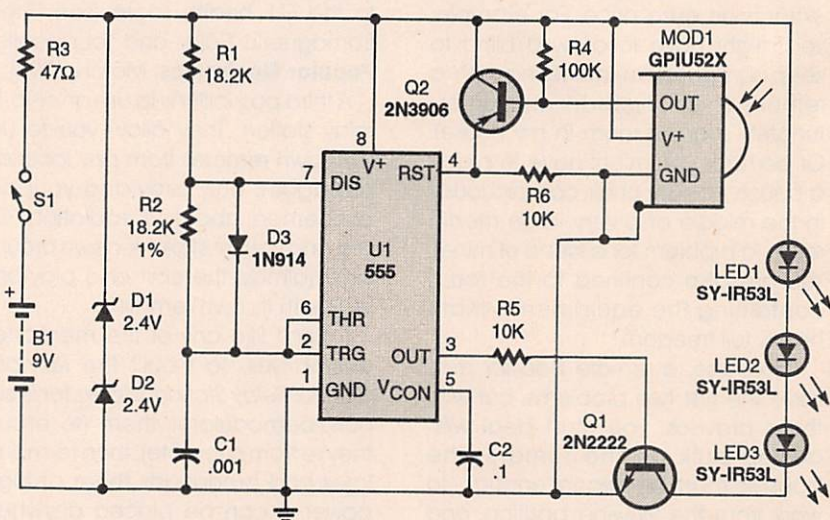
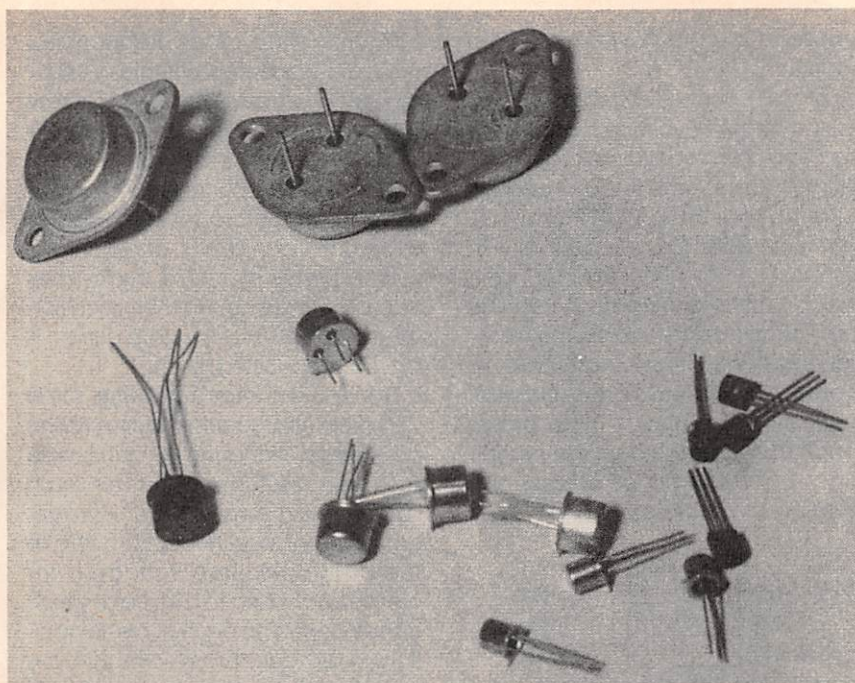


Fig. 3. In the IR-relay circuit, all of the signal processing is performed by the infrared detector/demodulator module, MOD1. The rest of the components regulate power and generate 40-kHz IR pulses.

is received, and high during pauses between bursts. The resulting waveform is an inverted version of the pulses that were modulated and transmitted by the remote. Let's turn our attention to the project to see how those signals are put to use.

The Relay Circuit. A schematic diagram of the Remote-Control Relay Station is shown in Fig. 3. To summarize its pertinent features, it consists of the IR-detector module (MOD1) connected to an inverter (made of Q2,

(Continued from page 96)



All About Transistors:

FET's

BY ROBERT A. YOUNG

The lowly transistor evolved from bipolar to JFET to MOSFET to CMOS—which today forms the basis of many industrial and commercial products.

It may seem hard to believe, but it was not too long ago that bipolar transistors began to replace vacuum tubes in mainstream electronic design. Low power, small size, and durability were only a few of the characteristics that propelled those little globs of silicon into the forefront of electronics. However, tube circuits didn't abruptly disappear when transistors hit the scene in part because bipolar transistors have a low input impedance, are noisy, and must be safeguarded against thermal runaway.

When the field-effect transistor (FET) was introduced, it overcame many of the shortcomings of bipolar units. In fact, it combined many of the advantages of bipolar transistors and vacuum tubes into a single package. Thus, several devices that were traditionally vacuum-tube based began to show up in transistorized form. However, before we take a look at the FET, let's take a look again at its forerunner, the bipolar transistor.

Bipolar Transistors. Figure 1 shows the composition of a PNP bipolar transistor. As shown, N-doped semiconductor material is sandwiched between two pieces of P-doped material. The base is comprised of the N-type material, while the collector and emitter of the transistor is made up of P-type material.

In order for a PNP transistor to conduct, its collector must be made more negative than its base, and its base more negative than its emitter. That condition is called "forward biasing." Note that the potential (or voltage) polarity is not specified. That's because bipolar transistors can be operated from either a negative or positive source, as long as they are properly biased.

Current flow between the base-emitter junction causes current flow in the emitter-collector junction. NPN transistors operate in the exact same manner except current flow is in the opposite direction, and their bias voltages are reversed as well; e.g., for an NPN transistor to operate, its collector must be more positive than its base, and its base more positive than its emitter terminal.

It doesn't take a deep understanding of transistor physics to see that the two separate junctions (base-emitter and collector-base) behave much the same as two diodes. The input impedance of a bipolar transistor is consequently very much the same as a forward-biased diode (it's low). That's one of the main reasons that the introduction of the transistor did not totally do away with vacuum tubes. Since vacuum tubes have an inherently high input impedance, it was much easier to use them than to devise additional circuits to provide bipolar

transistors with similar desirable characteristics.

Enter the FET. While bipolar transistors are basically current amplifiers, field-effect transistors (FET's)—which are unipolar rather than bipolar devices—are voltage amplifiers. FET's have certain properties that are superior to those of bipolar transistors. For instance, voltage rather than current operation, extremely high input impedance, virtually constant current with respect to voltage at specified bias levels, current change that is inversely (rather than directly) proportional to temperature, as well as faster switching speeds and thus higher cut-off frequencies. Despite those advantages, the FET has not replaced bipolar transistors in all applications.

There are two major classes of FET: the junction field-effect transistor or JFET, and the metal-oxide semiconductor field-effect transistor or MOSFET (which is sometimes called an "insulated-gate FET" or "IGFET"). FET's are further categorized by channel type (N or P), and as being normally on (depletion) or normally off (enhancement).

Cross sectional views of both N- and P-channel JFET's are shown in Figs 2A and 2B, respectively. As shown in Fig. 2A, an N-channel JFET is formed by embedding (channeling) N-type material in a P-type substrate. The P-type

substrate is referred to as the "gate," while the two regions of embedded N-type material are designated the "source" and the "drain". Respectively speaking, the source, gate, and drain of a FET are analogous to the collector, base, and emitter of a bipolar transistor.

Source and drain terminals are formed directly on the N-channel material and the gate terminal is formed on the P-type area. The symmetrical construction of the JFET permits the drain and source to be interchanged, if necessary. The schematic symbols for both N- and P-channel FET's are shown in Figs. 2C and 2D, respectively.

FET Operation. There are two inter-related factors that control the performance of a FET (i.e., current flow through the embedded channel); the voltage between the gate and source (V_{gs}); and the voltage from drain-to-source (V_{ds}). If the gate-to-source voltage is at ground (zero volts) with the drain connected to a positive voltage and the source tied to ground, the electron shortage in the channel restricts the amount of current that can flow through the channel. The only way to increase current flow is to increase the drain-to-source voltage.

Let's take a look at what happens when a signal source is connected to the gate of a FET and a positive voltage is applied to the drain (refer to Fig. 2A). If a positive voltage is applied to the drain and a negative voltage is applied to the source with the gate terminal open, a drain current flows.

When the gate is biased negative with respect to the source, the PN junction is reverse biased, which causes a depletion region to form. Because the N-channel is more lightly doped than the P-type gate material, the depletion region penetrates into the N-channel. The depletion region, which behaves like an insulator, causes the N-channel to narrow, increasing the channel resistance. If the gate bias is made even more negative, the drain current is eventually cut off completely. The voltage at which that happens is called the "pinch-off" or "gate cut-off" voltage. On the other hand, as the gate bias is made more positive, the depletion region shrinks, reducing the source-to-drain resistance, which in turn causes an in-

crease in current flow through the channel.

For a P-channel JFET (refer to Fig. 2B), if a negative voltage is applied to the drain and a positive voltage to the source with the gate terminal open, a current flows through the channel. When the gate is made positive with respect to the source, the depletion region begins to increase, narrowing the P-channel and causing the channel's resistance to increase. The increased resistance of the channel reduces current flow. If gate bias is made more positive and reaches the pinch-off or gate cut-off voltage, current flow is completely choked off.

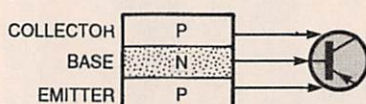


Fig. 1. In essence, a PNP bipolar transistor is comprised of N-doped semiconductor material sandwiched between two pieces of P-doped material.

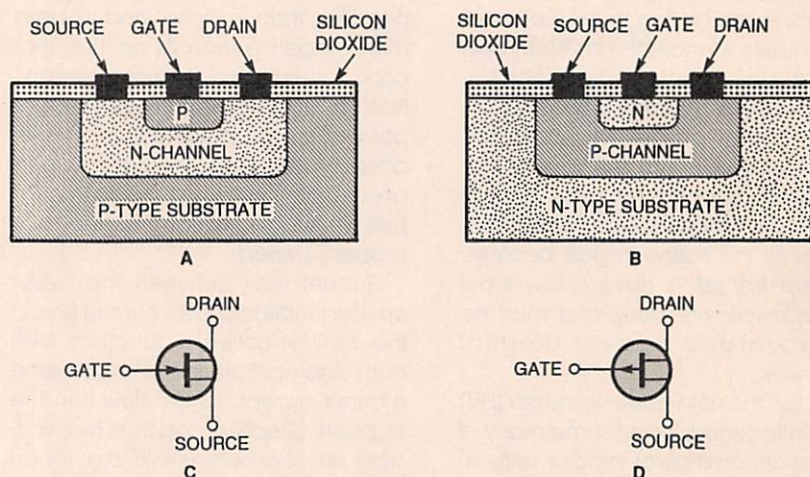


Fig. 2. These cross-sectional views of N- (A) and P-channel (B) JFET structures show that a JFET is formed by embedding either N- or P-doped semiconductor material (the channel) in an N- or P-type substrate (the gate). The schematic symbols for N- and P-channel JFET's are shown in C and D, respectively.

On the other hand, as the bias becomes more negative, the depletion region shrinks, reducing the source-to-drain resistance, increasing current flow. Thus, the gate actually controls current flow through the channel.

The gate-to-source junction of a JFET has the characteristics of a silicon diode; that is, when reverse biased, gate leakage current is in the thousands of microamps at room temperature. Actual gate-signal current is only a fraction of that and the input impedance to the gate is typically

1000 megohms at low frequencies. The gate junction is effectively shunted by a capacitance of a few picofarads, so its input impedance falls as frequency increases.

If the gate-to-source junction of the JFET is forward biased, it conducts like a normal silicon diode, and if it is severely reverse biased, it avalanches like a Zener diode. Neither condition will harm the JFET if the gate current is limited to specified levels.

Figure 3 is a graph showing some JFET-drain characteristic curves (in this case, for an N-channel JFET). It can be seen from that graph that for each value of gate-to-source voltage, drain current rises linearly from zero as the drain-to-source voltage is increased from zero to a value at which a knee occurs on each curve. In addition, drain current remains virtually constant as the drain-to-source voltage is increased beyond the knee.

Therefore, when the drain-to-source voltage for any of the gate-to-

source voltage curves is below its knee value, the drain-to-source terminals of the JFET act like a voltage-variable resistor whose value is determined by the applied gate-to-source voltage. The drain-to-source resistance (R_{ds}) can be varied from several hundred ohms to several thousand megohms. That characteristic permits the JFET to be used as a voltage-controlled switch. The drain's characteristic curve also shows that when the drain-to-source voltage is above the knee value, the drain current is dic-

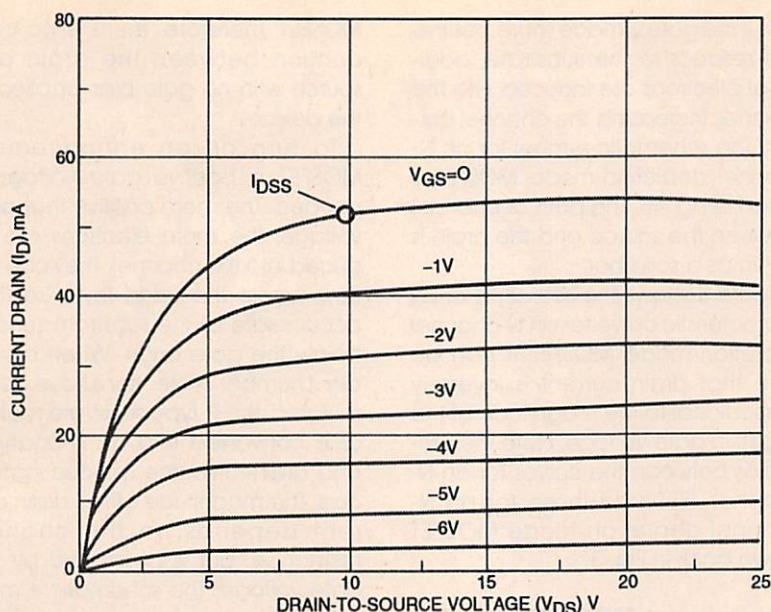


Fig. 3. This graph shows the N-channel JFET's drain-characteristic curve under differing operating conditions. Note that drain current rises linearly from zero as the drain-to-source voltage is increased from zero to a value at which a knee occurs on each curve.

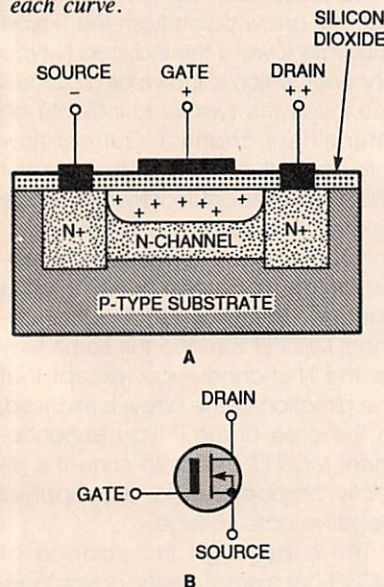


Fig. 4. A cross-sectional view of an N-channel depletion-mode MOSFET is shown in A; its schematic symbol is shown in B. Note that the path or channel between the source and the drain is shown as a solid bar.

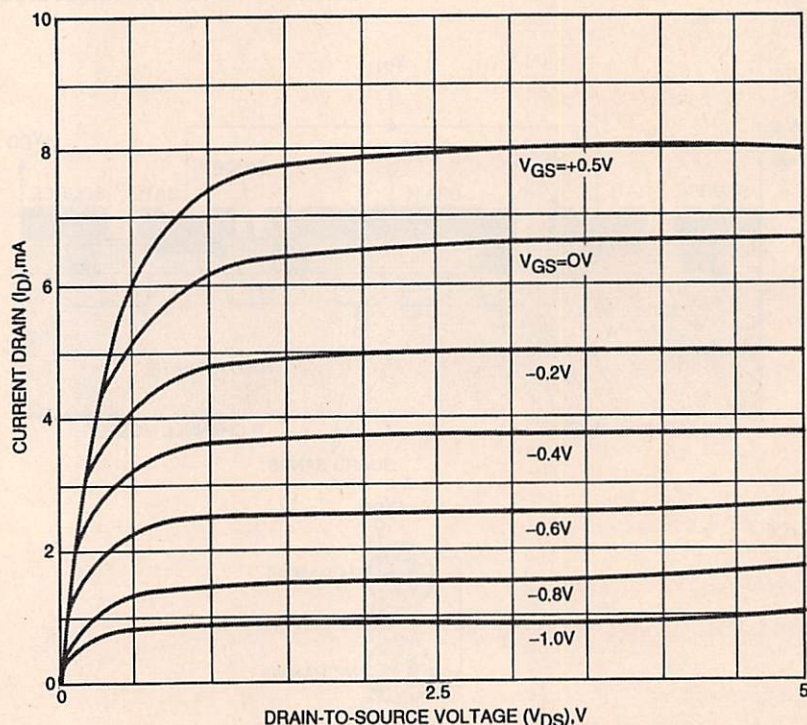


Fig. 5. It can be seen from this source-to-drain characteristic curve for an N-channel depletion-mode MOSFET that the drain current is inversely proportional to the magnitude of any applied negative gate voltage. Note the similarities between the curves for an N-channel JFET and those for an N-channel depletion-mode MOSFET (shown back in Fig. 3).

tated primarily by the gate-to-source voltage, and is essentially independent of the drain-to-source voltage. That allows the JFET to function as voltage-controlled current generator.

The gain of the JFET is specified as a transconductance (g_m); e.g., the rate of drain-current change with respect to gate voltage. A gain of 5-mA-per-volt indicates that a variation of 1 volt at the gate produces a 5-mA change in drain current.

Note that transistor structures back in Fig. 2A and Fig. 2B, are complementary to each other: e.g., in Fig. 2A the channel is comprised of N-type material and the gate and the substrate are composed of P-type material, but in Fig. 2B the channel is comprised of

P-type material and the gate and the substrate are composed of N-type material. Thus, the bias voltages for N-channel and P-channel JFET's are opposite each other.

MOSFET's. The metal-oxide semiconductor field-effect transistor (MOSFET), developed as an improved JFET, has become one of the most important forms of FET. A MOSFET is almost the same as a JFET, but instead of having a direct connection between the gate and the substrate, the gate is isolated from the channel by a thin insulator (usually a film of silicon dioxide).

Figure 4A shows a cross-sectional view of an N-channel depletion-mode MOSFET. The gate of the MOSFET is fully insulated from the adjacent channel—which is the most important difference between it and an N-type JFET.

When the drain is positive with respect to the source, a current flows even if the applied gate voltage is zero. However, if the gate is made negative with respect to the substrate, positively charged carriers (holes) induced in the N-channel combine

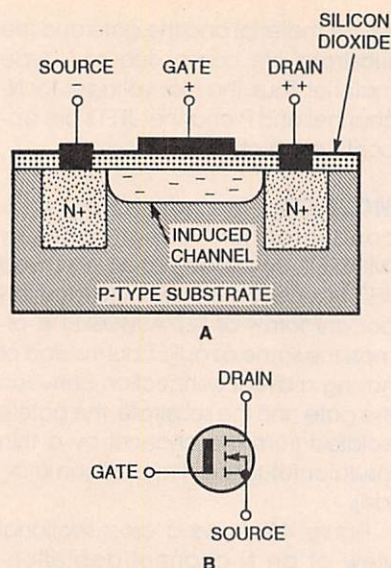


Fig. 6. A shows a cross sectional view of an N-channel Enhancement MOSFET, which is made by using the same process used to manufacture depletion MOSFET's. Its schematic symbol is shown in B.

ever, if the gate is made more positive with respect to the substrate, additional electrons are induced into the channel, increasing the channel current. The schematic symbol for an N-channel depletion-mode MOSFET is shown in Fig. 4B. The path or channel between the source and the drain is shown as a solid bar.

Figure 5 shows the source-to-drain characteristic curve for an N-channel depletion-mode MOSFET. It can be seen that drain current is inversely proportional to the magnitude of the negative gate voltage. Note the similarities between the curves for an N-channel JFET and those for an N-channel depletion-mode MOSFET shown back in Fig. 3.

Enhancement MOSFET's. Figure 6 shows a cross sectional view of an N-channel enhancement MOSFET. Enhancement MOSFET's are manufactured using the same methods used to

MOSFET. Therefore, there is no conduction between the drain and source with no gate bias applied to the device.

To turn on an enhancement MOSFET, a positive gate voltage is needed. The more positive that gate voltage, the more electrons are induced into the channel. They can not flow across the oxide layer, so they accumulate at the substrate surface below the gate oxide. When a sufficient number of electrons have accumulated, the P-type substrate material is converted into an N-channel, and drain-to-source conduction occurs. The magnitude of the drain current depends on the channel resistance, but is controlled by the gate voltage. The schematic symbol for an N-type enhancement MOSFET is shown in Fig. 6B.

In that symbol, the gate does not make direct contact with the channel. The arrow points from the P-type substrate toward the induced N-type channel, which is shown as a dashed line inside the symbol to indicate an intermittent channel. Current flow through both types of enhancement MOSFET is proportional to the voltage applied to their gates, and drain current is directly proportional to the value of any applied positive gate voltage. The P-channel enhancement MOSFET is made the same way as the N-channel type, except that the direction of the arrow is reversed. In the case of the P-type enhancement MOSFET, the drain current is directly proportional to any applied negative gate voltage.

The super-high impedance of MOSFET's is a great design advantage, but it makes them susceptible to damage from even low-energy electro-static discharge (ESD). It doesn't take much static build-up to produce a charge large enough to puncture the insulating oxide of a MOSFET, destroying the component. For that reason, discrete MOSFET's (as well as the IC's that incorporate them) are often protected with internal Zener diodes.

In spite of its susceptibility to ESD, the MOSFET comes very close to bridging the gap between vacuum tubes and semiconductors. Since the gate is totally isolated from the substrate, its input impedance ranges up into the hundreds of megohms.

(Continued on page 94)

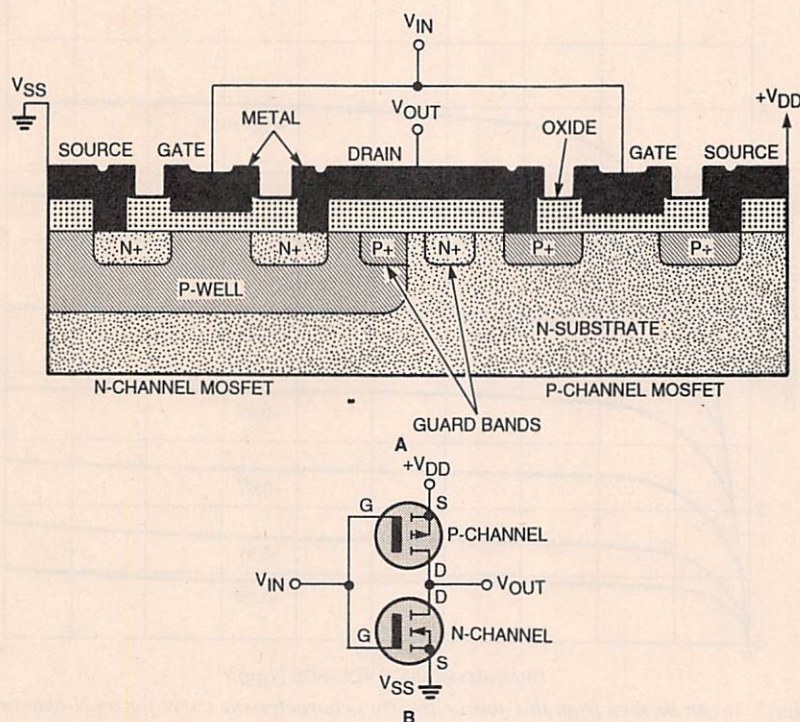


Fig. 7. A cross-sectional view of a complementary pair of MOSFET's implemented on a common substrate is shown in A. The same connection arrangement is shown schematically in B. Note that the two FET's share common gate and drain terminals, and while one source terminal is tied to V_{dd} , the other is tied to V_{ss} .

with the electrons and cause channel resistance to increase. With increasingly negative bias, the drain current diminishes until the pinch-off voltage is reached, at which point current flow ceases altogether. How-

manufacture depletion MOSFET's. However, the enhancement MOSFET (see Fig. 6A) does not have the N-doped drain-to-source channel through the P-type substrate as is the case with the N-channel depletion

ANTIQUE RADIO

By Marc Ellis

Getting Started on the NBS Crystal Set

In last month's column, we resumed our discussion of the National Bureau of Standards crystal set, a topic that was opened in the January issue and then set aside for a while in order to provide timely coverage of last September's Antique Wireless Association annual conference. Last month we reviewed the history of the NBS project as well as the radio's circuitry and construction style. At the close of the column, we talked about some of the issues relating to the choice of a form for the tuning coil.



To start the coil winding, turn the canister upside down and secure the end of the wire by threading it through a couple of small holes poked just under the edge of the bottom cap.

The original specifications called for the coil to be wound on a cylindrical cardboard one-pint container of a type no longer manufactured (or at least very rare). In any case, I really had my heart set on using the time-honored Quaker Oats canister as a coil form. The problem was that the diameter of the

Quaker Oats canister—even the smaller one used for the "Quick Oats" product—was too great. As a compromise, I settled on a Quaker "Quick Grits" canister, which does have a diameter close to the required $3\frac{1}{2}$ inches.

Admittedly, "Quick Grits" doesn't have the same romantic ring as "Quick Oats." But at least it is a Quaker Oats product, and, in any case, the artwork on the package is completely covered by the coil windings. If you're still disappointed, all I can do is apologize; this is the closest I can come to keeping the faith!

WINDING THE COIL

After you get your Quick Grits home from the store, open the canister by pulling the string that cuts the paper seal around the cardboard end cap. The cap should now be removed intact, and you have to be careful here because it probably won't come off freely.

Slide a thin knife blade under the side of the cap and carefully work it around the circumference until the cap comes loose. Set it aside for future use and remove the grits from the canister. Now you can begin winding the coil.

I used some No. 22 enamel-covered "magnet wire" that I happened to have on hand, and my completed coil was a bit short of the $2\frac{1}{2}$ -inch length called for in the original construction article. The No. 21 size available from Antique Electronic Supply or Antique Audio (see previous column), being slightly

heavier, should work out a little better.

Now turn the canister upside down and poke a couple of holes (using a small finishing nail) about a half an inch apart and just under the ridge formed by the edge of the canister's permanent bottom cap. Turn the canister so that the holes face you, and thread the free end of your coil wire down through the left one and up through the right one.

Form the "tail" emerging from the right-hand hole into a "U" shape, then twist with long-nose pliers to form an eyelet. A finishing nail inserted through the "U" also makes a good twisting tool. That eyelet, and the others you will make as you continue to wind the coil, are the "taps"; they will be used to make electrical connections to the coil later on.

Now that the end of the wire is firmly held in place, you can begin winding. Keeping constant tension on the wire, turn the canister slowly to the right so that the first coil turn falls right under the edge of the cap. Maintain the tension



Here's the coil as it looks when completed. The canister has been cut to size and the top cap (now at the bottom) has been temporarily reinstalled.

and continue winding, keeping each turn as close to the previous one as possible. When you reach the 12th turn, twist another eyelet into the wire, similar to the first one and directly underneath it.

Continue winding, twisting on an eyelet—as above—every twelve turns, until you have wound a total of 60 turns on the coil. You should now have six eyelets, including the one you first installed at the start of the coil. In the completed set, those 12-turn taps will be used to make coarse tuning adjustments on the received signal.

You're now going to wind on a six-turn "spacer winding" followed by five two-turn windings, installing an eyelet (so that you'll have a total of six more) at the end of each one. The two-turn taps will be used to make fine-tuning adjustments on the received signal.

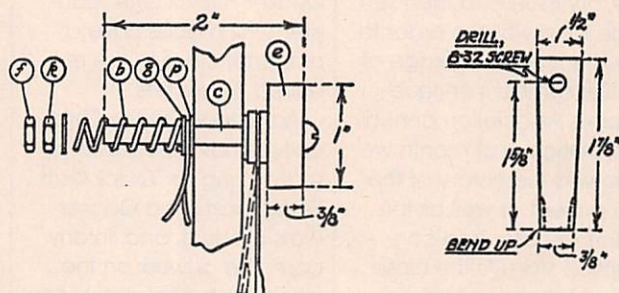
Since the eyelets are now coming very close together, don't continue placing them in a straight vertical line. Add about a half-inch to the last turn of each winding so that the eyelets will be staggered along the circumference of the coil. That will make things a little easier later on, when you'll sand the enamel off the eyelets and solder connections to them.

About half an inch after your last eyelet, poke two holes similar to the ones you made at the start of this coil. Cut off the magnet wire a few inches after the eyelet and secure the free end by threading it through the two holes as before. After the threading, cut off the excess length, leaving a short (perhaps 1/4-inch) "tail" protruding from the second hole. For neatness, bend it over so that it lies flat.

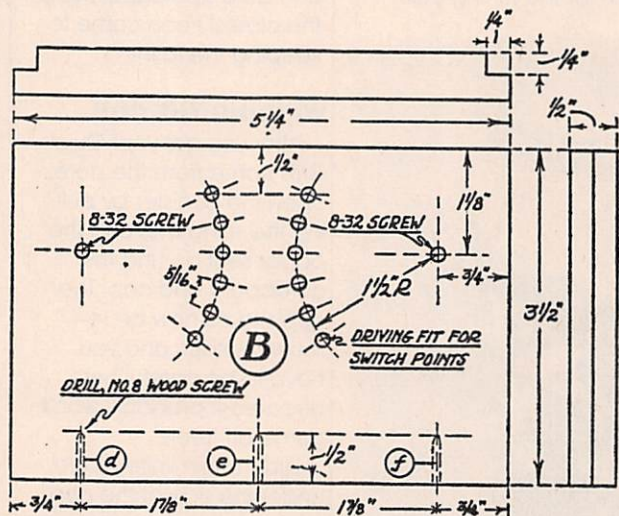
The completed coil should contain 76 turns and

be about 2 1/2 inches long. (A diagram from the original construction article, showing the layout of a completed coil, was included with last month's article.) If you've wound your turns tightly, the winding should be quite stable on its cardboard form. However, if you'd like to be a

mark the canister for trimming so that a stub equivalent to that depth will extend beyond the end of the windings. After trimming with your matte knife, slide the cover onto this stub. (It will be a tight fit, so be careful!) Don't glue it just yet; that will come a bit later.



For those adventurers who would like to make authentic tap switches, here are two views showing construction. See the text for more details.



The front-panel layout shows the exact locations of the brass brads used for switch points. Leave these out if you are going to use commercial rotary switches (see text).

little compulsive (as I was), you might want to anchor the turns more securely by spraying the coil with a few thin coats of quick-drying lacquer.

Your final step will be to trim the Quaker Grits canister to size. First, using a matte knife, neatly cut the loose paper from around the edge of the cover you removed at the beginning of this project. Measure the depth of the cover, then

TAP SWITCH CONSTRUCTION

Back in 1924, set builders regularly made items that we wouldn't think of building for ourselves today. For example, the original construction article provided details on how to construct both the two tap switches used with the tuning coil and the stand for the crystal detector.

I've already served notice that that type of fussy me-

chanical construction isn't my bag! I intend to use rotary switches and a commercially available replica crystal stand in my own version of the NBS set. However, for those who want to build a 100% authentic set, I'll conclude this month with some details about the tap switches used in the original project.

A pair of drawings showing parts of the switch-contact assembly is included with this article. You'll need to build two of these assemblies; one for coarse tuning and one for fine. The switch blade is cut and bent, as shown, from No. 24 spring brass sheet "with the grain of the metal running the long way."

The contact assembly parts are assembled on a two-inch 8-32 brass machine screw. First, slide on the knob, which is cut from a fiber rod. Then add the blade, sandwiched between a couple of washers (make one of them a lock washer). Secure the blade by pinning on a brass nut and tightening securely. You might like to back up the nut with another washer to keep it from digging into the wood front panel as the switch is turned.

After giving the blade a slight bend, as shown by the dotted lines, and passing the screw through its hole in the front panel (to be described later), the remaining parts are added to the assembly. Those include brass washers "g" and "p", tension spring "b" (which is formed by wrapping 10 turns of No. 20 piano wire around a 3/16-inch rod clamped in a vise), another brass washer, and a pair of nuts to lock the assembly in place. The twist of wire locked between washers "g" and "p" represents the electrical hookup to the

(Continued on page 78)

COMPUTER BITS

By Jeff Holtzman

Just a Click Away

The Windows Program Manager is one of the most maligned pieces of software in history—and deservedly so. I've been searching for a better interface since the days of Windows 2.0. I've tried numerous commercial and shareware products, and none has ever been able to totally satisfy my needs.

package with everything including the kitchen sink. In that category, Norton's Desktop for Windows (NDW) is the best that I've found. But certain things about NDW continue to bother me, like the occasional video instability, the tremendous amount of disk space required, glacially slow start-up time, incompatibility and the lack of synchronization with Program Manager icon groups, occasional incompatibilities with the installation routines of various programs, the lack of icon docking, and the lack of a more object-oriented desktop (like OS/2) that would allow you to clone drive icons and file lists. On the other hand, I really like NDW's file viewing and management system. It's much more efficient than Windows' own File Manager.

However, one day, my copy of NDW broke. It simply refused to load. Faced with the prospect of reloading it from floppies, I decided to go cold turkey. I have missed it—but not as much as I thought I would. What made the biggest difference was a program called Outside In, which can attach itself to the Windows File Manager and give pretty much the effect of NDW's file viewer/manager. But replacing Program Manager took much more effort.

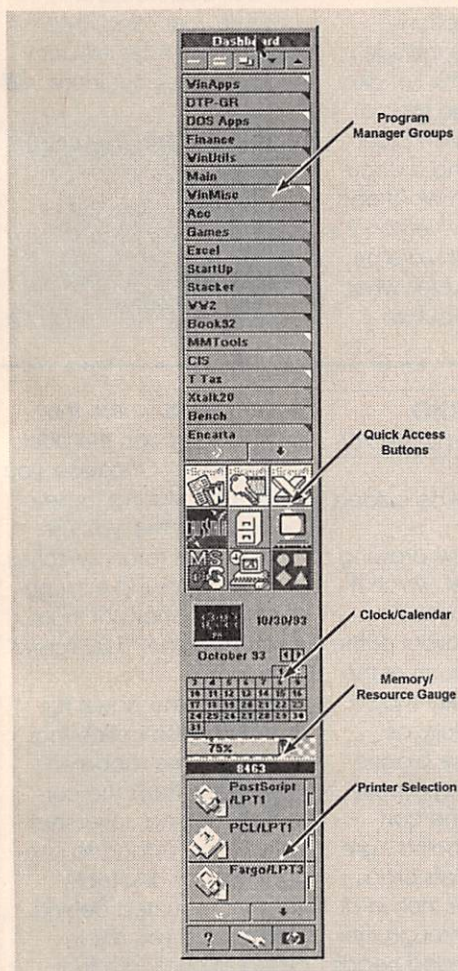
For a short time, I used a program called SideBar, which has a really elegant design, but the early version that I looked at had bugs and was somewhat wasteful of screen real estate.

Then Hewlett-Packard released a program called DashBoard. Although intrigued, I never got around to trying Version 1. Recently, they released Version 2, and have made it widely available for \$30–\$60. At that price, I couldn't afford not to check it out, and it looks like a keeper.

DASHBOARD

DashBoard gives you a highly configurable bar that you can spread horizontally or vertically across your screen. The bar can hold icons for your favorite programs, a clock/calendar, a memory/resource gauge, printer icons for instantly switching among several printers, a virtual screen manager, and more. Click a program icon and the associated program runs. Click a program group, and a list of programs in that group appears. Double click a program group, and a Program Manager-like icon group pops up. The changes that you make to those groups are reflected in Program Manager. For example, you can copy, move, and delete icons, pack them, and optionally sort them alphabetically by title. In addition, you can create nested groups (groups within groups), but those are only good in DashBoard.

DashBoard can work in conjunction with Program Manager or replace it. DashBoard can also replace Task Manager, but this is one area where the competition (e.g., the Metz Task Manager and the Boyan Task Manager) provide more power. Nonetheless,



DashBoard, from Hewlett-Packard, is the most economical, effective, and efficient Windows shell available. It allows you to add your own quick access buttons, program groups, printer-selection icons, and more. Then whatever you need is just a click away.

My needs tend to run in cyclical extremes. Most of the time I want a full-blown

DashBoard—as a single-product replacement for both Program Manager and Task Manager—is highly appealing, especially so because DashBoard occupies a mere 1.8MB of disk space. My NDW subdirectory used to occupy nearly ten times that amount!

It's amazing how much HP has been able to pack into 1.8MB. For example, the Clock/Calendar allows you to set alarms, either one-time or recurring. When the specified moment occurs, the program can pop up a reminder, run a program, play a tune (a Windows WAV file), or all of those. However, repetitive alarms can only be set to occur on specific days of the week or every day. Longer time periods (e.g., weekly, bi-weekly, semi-monthly, monthly, quarterly, and yearly) are not supported.

The system-resource monitor keeps track of how

much general memory and system memory you have available, and can sound an alarm if either falls below a specified threshold. DashBoard provides similar resource tracking for your disk drives. All of those items are configurable. If you don't need or want them, you turn them off.

Another useful function is DashBoard's "Run Box." It provides a DOS-like command-line window, complete with a scroll-back buffer, in which you can list directories, copy files, and so forth. You can also launch both DOS and Windows programs—even Windows PIF files—from the Run Box, either by typing the corresponding name, or by double-clicking the name in a directory list.

I have three complaints here. One is the washed out font used in the Run Box. Second is that there doesn't seem to be any way to

access the Run Box directly from the main DashBoard bar. However, you can assign a hot key that will pop the Run Box up over any running application. Third is that you can't copy text (e.g., a directory listing) out of the Run Box.

DashBoard provides you extensive abilities to customize fonts (except in a few places like the Run Box), colors, sort orders, icon titles, icon sizes, and more. You can even save named configurations (called Layouts) and recall them later.

In addition to the customization options, Layouts can also include running programs. For example, you could save a Finance layout with Excel and Quicken, and a document layout with Word and Visio (by the way Version 2 is out—and it's hot! More on that next time). Later, when you reload a layout, all

customization options take effect, and all associated programs are loaded.

However, layouts do not include files loaded by those programs. To compensate, DashBoard allows you to edit the command line that starts each program in a layout. However, it would be better to be able to save a layout and simply have everything appear in the precise state it was in the last time you used that layout.

You may not be in the habit of thinking of HP as a mainstream PC software vendor. DashBoard will change your mind. Byte for byte, it's the most efficient Windows shell out there. ■

VENDOR INFORMATION

DashBoard
Hewlett-Packard Co.
PC Software Division
974 E. Arques Avenue
Sunnyvale, CA 94086
800-752-0900

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ANTIQUE RADIO

(Continued from page 76)

switch, which will be added later.

Now refer to the drawing of the front panel, which is cut from 1/2-inch wood stock. Note the layout of the six contacts for each of the two switches. These should be placed carefully, as shown, so that the blades will contact them properly after assembly. The contacts, or "switch points," are simply 3/4-inch brass brads (approximately 1/8-inch in diameter) driven through the board. Their rounded heads should be flattened out with a file prior to installation. Two 1/2-inch brass brads are installed on the panel at each switch position to act as blade stops.

Electrical connections will later be soldered to the "business ends" of the

switch points, where they protrude through the back of the panel. Of course, you won't be installing those points if, like me, you use commercial rotary switches. Just drill holes big enough to pass the shafts of those switches at the "8-32 screw" locations.

Studying the panel further, you'll also notice that the edges are rabbeted out (I hope that's the correct term) for a cover that will later be added to conceal the coil assembly, which is mounted behind the panel. If you are inclined to duplicate that feature, you should obviously do it before installing the switch points. Also, drill the three holes, as shown, that will accept the screws used to fasten the panel to its wood base. We'll continue construction of the NBS set next month. ■

CIRCUIT CIRCUS

By Charles D. Rakes

Some Assorted Circuits

This month, I want to share a number of circuits, ranging from a single-chip radio receiver to an audible voltmeter. Hopefully, at least one of these circuits will fill a void in an on-going project or a future one. In any event, get ready for some experimenting.

There's no doubt that the popular NE602 double-balanced mixer/oscillator is the star IC of the DC (direct-conversion) receiver. At least that's been the case for the last few years. As popular as the NE602 has become, it's not without its faults. The number one complaint is its limited dynamic range. That means that the NE602 can not handle input-signal levels that vary greatly in strength. To overcome that problem,

SEMICONDUCTORS

U1—TDA7000 single-chip FM radio, integrated circuit
U2—LM386 low-voltage audio-power amplifier, integrated circuit

CAPACITORS

C1—100-pF, ceramic-disc
C2—C4—0.22- μ F, ceramic-disc
C5, C6—365-pF variable
C7, C8—470- μ F, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

R1—5000-ohm potentiometer
L1, L2—See text
S1—SPST switch
Perfboard materials, T80-2 toroid (D.C. Electronics), #28 magnet wire, IC sockets, 9-volt power source, wire, solder, hardware, etc.

an RF attenuator must be added and constantly adjusted as input levels change.

Another chip to consider for receiver applications is the TDA7000 single-chip FM receiver (originally designed for use in portable radios, TV's, cordless phones, and other receiving equipment), which can be operated from a 4- to 12-volt DC source with a current drain of about 10 mA. The TDA7000's input circuit offers a much wider dynamic range than does the NE602. Furthermore, even though it's designed for FM applications, the TDA7000's oscillator and mixer can be used to build an excellent receiver.

ONE-CHIP RECEIVER

Take a look at the schematic diagram of the receiver circuit shown Fig. 1. About all you have to do is wind two coils, connect a few components together, tie the input to a simple wire antenna, and a receiver is born. The two coils,

L1 and L2, are each comprised of 100 turns of #28 enamel-covered, copper, magnet wire wound on T80-2 toroid cores (with a tap at the 30th turn on L1). The toroid cores and the TDA7000 are available from D.C. Electronics, P.O. (3203, Scottsdale, AZ 85271-3203;

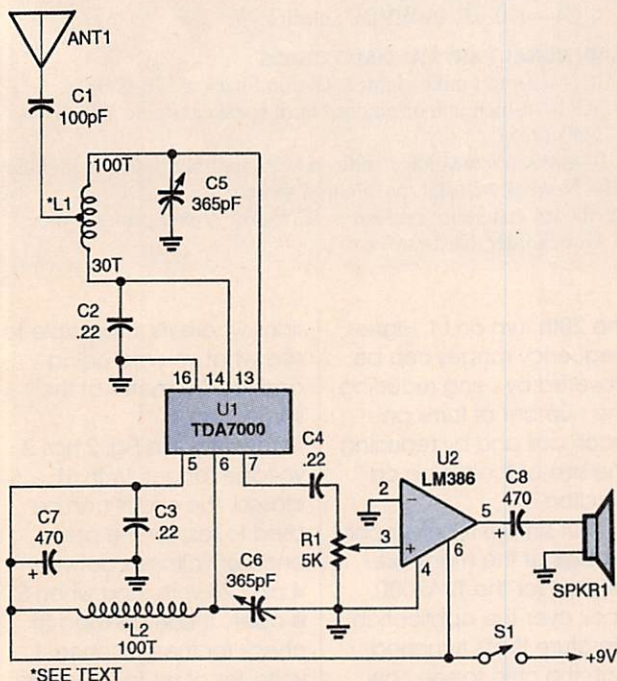


Fig. 1. The DC Receiver is comprised of a TDA7000 single-chip FM receiver (U1), an LM386 low-voltage audio-power amplifier (U2), a pair of hand-wound coils (L1 and L2), and a few additional components.

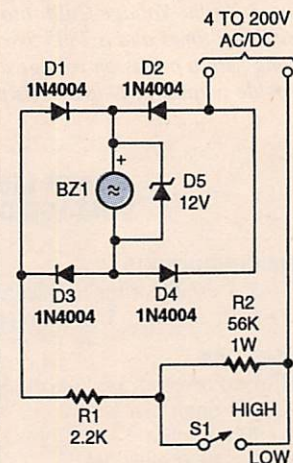


Fig. 2. The Audible Voltmeter can be used to test for AC or DC voltages in a circuit. With S1 closed, the circuit can be used to test for voltages between 4 and 24 volts, and when S1 is open, it can be used to check for the presence voltages of up to 200 volts.

Tel. 800-467-7736).

Although the manufacturer's specifications don't recommend operating the chip below 1.5 MHz, we operated ours in the stan-

dard AM-broadcast band. The 160-meter amateur band can be covered by winding about 70 turns of the same wire (#28) on the T80-2 cores with a tap at

PARTS LIST FOR THE AUDIBLE VOLTMETER

SEMICONDUCTORS

D1-D4—1N4004 1-amp, 200-PIV, silicon rectifier diode
D5—12-volt Zener diode

RESISTORS

(All fixed resistors are 1/4-watt, 5% units unless otherwise noted.)

R1—2200-ohm
R2—56,000-ohm, 1-watt

ADDITIONAL PARTS AND MATERIALS

BZ1—Piezoelectric buzzer
S1—SPST switch
Perfboard materials, enclosure, wire, solder, hardware, etc.

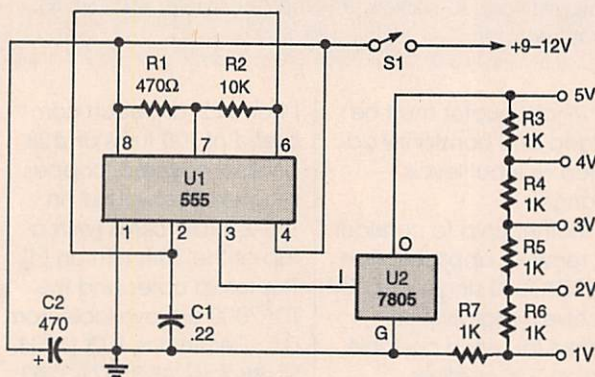


Fig. 3. In the Voltage Calibrator, two low-cost IC's—a 555 oscillator/timer and a 7805 5-volt 1.5-amp voltage regulator—along with a precision voltage divider network are used to provide outputs of 1- to 5-volts peak-to-peak.

PARTS LIST FOR THE VOLTAGE CALIBRATOR

SEMICONDUCTORS

U1—555 oscillator/timer, integrated circuit
U2—7805 5-volt, 1.5-amp, voltage-regulator, integrated circuit

RESISTORS

(All fixed resistors are 1/4-watt, 5% units, unless otherwise noted.)
R1—470-ohm
R2—10,000-ohm
R3-R7—1000-ohm, 1%.

CAPACITORS

C1—0.22-μF, ceramic-disc
C2—470-μF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

S1—SPST switch
Perfboard materials, enclosure, 9-12-volt power source, wire, solder, hardware, etc.

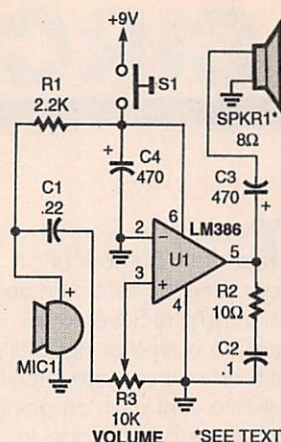


Fig. 4. The Mini-Megaphone is comprised of an electret microphone (MIC1), an LM386 low-voltage audio-power amplifier (U1), a horn speaker (SPKR1), and a few other components.

us a line or two (along with a schematic diagram) explaining your application and how it works. Send them to *Circuit Circus*, c/o **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. I'll share the best with our other friends.

AUDIBLE VOLTMETER

Next up is a simple audible voltmeter (see Fig. 2). The circuit can come in handy when you have to make a quick check to see if either an AC or DC voltage is present in a circuit. The tester can also be valuable when checking for voltages in difficult loca-

PARTS LIST FOR THE MINI-MEGAPHONE

RESISTORS

(All fixed resistors are 1/4-watt, 5% units.)

R1—2200-ohm
R2—10-ohm
R3—10,000-ohm potentiometer

CAPACITORS

C1—0.22-μF, ceramic-disc
C2—0.1-μF, ceramic-disc
C3, C4—470-μF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

MIC1—Electret mike element (Radio Shack #270-090)
SPKR1—4-inch indoor/outdoor horn speaker (Radio Shack #40-1235)
U1—LM386 low-voltage audio-power amplifier, integrated circuit
S1—Normally-closed, pushbutton switch
Perfboard materials, enclosure, IC socket, 9-volt power source, wire, solder, hardware, etc.

the 20th turn on L1. Higher frequency ranges can be covered by using reducing the number of turns on each coil and by reducing the size of the tuning capacitors.

That simple receiver only nibbles at the many uses offered for the TDA7000. Look over the application literature that's furnished with the chip to see how many different uses you can come up with. Once you've got your circuit up and running, why not drop

tions where it's impossible to see what you are doing and read a meter at the same time.

The circuit in Fig. 2 has 2 voltage ranges. With S1 closed, the circuit can be used to test for the presence of voltages between 4 and 24 volts, and when S1 is open, it can be used to check for the presence of voltages of up to 200 volts.

VOLTAGE CALIBRATOR

Our next circuit, see Fig. 3.
(Continued on page 90)

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April 1989

DX LISTENING

By Don Jensen

Shortwave-Broadcast Funding

What makes shortwave different from your hometown broadcast? "The first thing I noticed on shortwave was that there are no commercials," writes 16-year-old Brett Bymaster of Brownsburg, IN. "Why is this? Where do they get their money?"

The major international shortwave stations fall into two basic categories in terms of funding, Brett. Most are owned and operated by foreign governments or quasi-governmental agencies. The *Voice of America*,

voluntary contributions of faithful followers.

Besides those, Brett, there are some U.S. shortwave outlets that are either fully or partly supported by selling blocks of airtime to other program producers, such as the aforementioned preachers or various foreign dissident or exile groups.

What many SWLs don't realize, though, is that in addition, there are many hundreds of commercial stations on shortwave, the sort that regularly air commercial spots, product ads, slogans, jingles, and the rest. If they've escaped your notice, it's probably because they tend to be small and lower powered stations, mostly broadcasting in Spanish or Brazilian Portuguese from Latin America.

Those commercial operations aim their programs and ads at domestic listeners, just as do U.S. AM and FM broadcasters. If you tune in and stick to one of those local Latin SW'ers, you might also hear a "spot" for some less familiar—to *norteamericanos*, at least—soft drink like Inka Kola. Another way your local radio station differs from SW is in the way its signal reaches your receiver. Brett Bymaster has some other interesting questions about that.

"How many watts does a station like the BBC put out?" he continues. "Why can I pick it up a continent away, but I can't hear a local station 100 miles away? Is it just the wattage, or is there something special about the shortwave frequencies?"

In fact, Brett, it's both, al-

though the latter, the very nature of shortwave, that is most important. Major international broadcasters, such as the BBC, today use powerful transmitters that pump out plenty of wattage, typically 100,000 to 500,000 watts (often stated in kilowatts—100 to 500 kW). Not too many years ago, 50,000 watts was considered really high power on shortwave, more than enough to be heard clearly around the world.

But that world has changed. As certain SW stations upgraded to super-power transmitters, the rest (or those stations who could afford it) followed suit, going to higher powers as well. Today, most of the broadcasting "big boys" are "yelling louder," but by and large, because of the increased mutual interference resulting, aren't being heard much better than before. And the small stations that couldn't keep up in the power race are harder to hear than ever.

Consider, next, that small-town medium-wave AM station 100 miles from your home. Its modest transmitter, most likely, runs just 250 or 500 watts. The most powerful big city AM stations in the U.S. and Canada have 50,000-watt transmitters. Transmitter power does help a station punch out its signal. But that doesn't really account for the difference between the range of a shortwave station and that of a local radio broadcaster. That involves, mostly, the way in which radio waves, be they AM medium wave or shortwave, reach us.

When a radio signal

WJCR World Wide



WJCR World Wide P. O. Box 91 Upton, KY 42784 USA

This QSL verification card is sent to listeners by WJCR World Wide, one of the U.S. religious stations that rely on supporters' contributions to finance SW broadcasts.

the British Broadcasting Corp., and Radio Canada International are examples of SW broadcasters financed directly or indirectly by public monies.

A second source of funding for international broadcasting are religious donations. Religious broadcasters—be they major stations like HCJB in Quito, Ecuador, or individual preachers who buy airtime for their programs on various SW outlets—get their financial support from the

leaves the station's transmitting antenna, a part of the electromagnetic energy—called the ground wave—hugs the surface of the Earth. The other part of the radiated signal, called the sky wave, heads off into space, and before long, it encounters a series of charged gaseous layers encircling the Earth, 60 to 150 miles overhead in the ionosphere.

Depending on the frequency of the radio signal, the density of those gaseous layers, the time of day, and other factors, some of the outbound energy is reflected back to Earth. It skips in hundreds of miles from the original transmitter site only to bounce skyward again. In that way, multiple skips between the ionospheric layer and the Earth can take a sky-wave signal round the globe.

The sky-wave phenomenon is commonplace for signals on the shortwave frequencies, say, 3,000 to 30,000 kilohertz. It also happens to signals in the regular AM (540 to 1600 kHz.) band, but only during hours of darkness. Probably you have noticed that at night you may hear an AM station a thousand miles away on your car radio, one you can't hear during the day. But reliable day-and-night reception on the AM band, unlike shortwave listening, must rely on the Earth-hugging ground wave portion of the transmitted signal. Here, where electrical brute force does the trick, transmitter power is especially important.

A 50,000-watt, clear-channel AM station in a major U.S. city some 200

miles from your home may be heard quite well at noon, via ground wave, while a 250-watt two countries away cannot be heard at all at that time. However, on shortwave, if propagation conditions are right and the frequency is quiet enough, a sky-wave signal—even from a low-powered 25-watt station in Asia or South America—may come skipping in.

THE UN-THAI-ED KNOT

The BBC and *Radio Nederland* had planned to build a new shared relay station in Thailand, but money problems forced the Dutch to back out of the deal. The British, however, are pushing ahead on their own to build a four-transmitter complex at Nakhon Sawan, 250 kilometers north of the Thai capital, Bangkok.

Engineering studies, reportedly, are completed and, with the strong backing of the British Foreign Office, full funding was anticipated. Construction should be underway shortly, and the new station is expected to be on the air in two and a half to three years, relaying BBC programs throughout China, India, Pakistan, and Bangladesh.

SOUTHERN CAL CALL

West coast SWLs and other radio enthusiasts, attention! An all-band convention called *RADIO COM'94* is scheduled for August 10–14 at the Holiday Inn Bristol Plaza in Costa Mesa, CA. The weekend gathering is sponsored by the "American Shortwave Listeners Club" (ASWLC) and the "Southern California DX'ers" (SCADS).

RADIO COM'94 is open to all radio hobbyists worldwide and should be of interest to those whose in-

terests cover shortwave, medium- and low-frequency listening, VHF/UHF monitors, Morse fans, and those fascinated by all manner of digital modes. Broadcasters, radio vendors, and listening clubs are expected to have displays, and an equipment swap meet is planned.

Further information is available by sending a business-size stamped, self-addressed envelope to *RADIO COM'94*, 6398 Pheasant Drive, Buena Park, CA 90620.

DOWN THE DIAL

What are you hearing these days? Why not share your loggings with the rest of us? Drop a line to *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. Your comments and questions are always welcome!

Here are what others are reporting on SW.

LUXEMBOURG—15,350 kHz. *Radio Luxembourg* has been heard at around 2100 UTC with German-language programming and vintage musical pops. Its longtime English-language programming on 6,090 kHz has been off the air for more than a year, unfortunately.

PAKISTAN—15,550 kHz. *Radio Pakistan* is noted in English at 1730 UTC with a tourist information program and Pakistani music.

SINGAPORE—9,530 kHz. *Singapore Broadcasting Corp.* is expected to become a major regional shortwave voice this year with six new 250-kilowatt transmitters on the air. The Radio One English network is supposed to operate on this frequency and on 6,155 kHz.

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By Joseph J. Carr, K4IPV

Receiver Performance Today

With respect to receivers, we hams today are relatively lucky compared to our predecessors of a generation or two ago. Modern ham receivers, often part of a transceiver that also includes the transmitter, are a cut above some (but not all) older models.

Wandering through the display room of a ham-equipment dealer shows all sorts of gleaming cabinets fitted with digital displays.

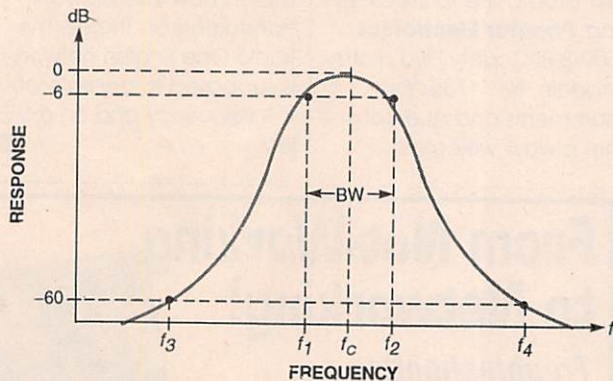


Fig. 1. The shape of the passband response plays a major role in determining receiver selectivity. Here the -6dB bandwidth (BW) is $f_2 - f_1$, centered on the design frequency, f_c . Note that the slope are broad and sloppy.

Almost all HF transceivers today contain a general-coverage receiver, even though the transmitter is limited to ham bands only.

Digital readouts are now commonplace on ham rigs. The readouts are basically digital frequency counters designed to measure the local oscillator (a variable-frequency oscillator or VFO) frequency inside the rig, but displays it with a numerical offset equal to the receiver's IF. In most cases, the digital readout is quite accurate, especially when compared to the dreadful calibration of some 1950's

and 1960's vintage receivers. In many of those earlier models, an accurate crystal calibrator was essential in order to avoid going out-of-band.

RECEIVER PARAMETERS

The principal performance indicators for radio receivers are: noise floor, VFO stability, sensitivity, selectivity, dynamic range, and third-order intercept. The noise floor is a measure of the basic noise created by the radio receiver itself. All electronic components, even a simple resistor, produce noise and, in extreme cases, the noise can interfere with the reception of weak signals. Normally, on HF it is not terribly important, while on VHF and up it can be terribly important. The reason for less (but not zero) concern for internal noise on HF is that the external noise (QRN) is so high that it masks any internal noise.

An oddity in the noise department was told to me by shortwave *guru* and author Harry Helms. He owns a number of HF receivers of both old and new designs. He noted that the older receivers, such as his Hammarlund HQ-180, had significantly lower noise floors than a couple of modern receivers. The difference seems to be the trash that can get into the receiver due to the internal digital frequency synthesizer and readout. For the convenience of digital, we apparently pay a noise penalty.

The VFO stability is usually measured in parts-per-million (PPM) or, more

commonly, as the number of hertz that the frequency changes from a cold start in about thirty minutes (more or less), or in terms of drift per hour of operation. Numbers like 50 and 100 Hz are relatively easy to obtain, especially in digitally synthesized units (which use a crystal oscillator as a reference frequency).

Sensitivity is the ability of the receiver to pick up weak signals, and so is a measure of the receiver gain. Generally, sensitivity is expressed in terms of the number of microvolts (μV) needed to achieve some specified signal-to-noise ratio; numbers like $0.15 \mu\text{V}$ or $0.5 \mu\text{V}$ are common. Be careful, though, a large increase in apparent sensitivity is possible by manipulating the numbers or the conditions of the test. Specific attention should be paid to the bandwidth of the receiver during the test.

Another method of specifying sensitivity is to use the power equivalent of the signal-voltage level under similar conditions. It is common to use dBm units, which are decibels relative to 1 mW (0.001 W) in a 50-ohm load.

The selectivity is a measure of the receiver's ability to separate adjacent signals, and is usually measured in frequency units. A typical ham receiver will have a bandwidth of 200 or 500 Hz for CW filters, 1.8 to 2.9 kHz for SSB filters, and 4 to 6 kHz for AM filters. But the bandwidth is not the only thing to worry about. The specified bandwidths are usually

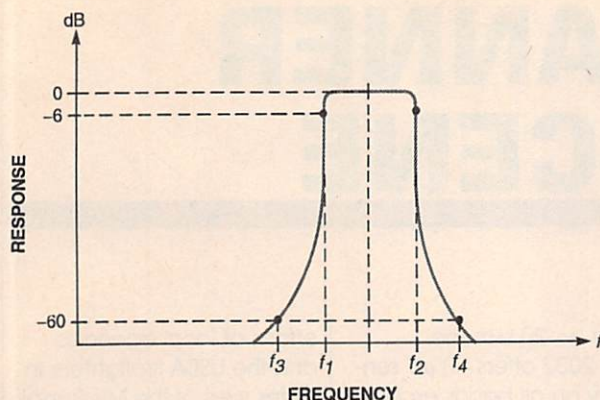


Fig. 2. Here the filter response is sharper, so the -60dB bandwidth is much smaller than before. Because of the -60dB bandwidth difference, this filter will generally outperform the previous filter in Fig. 1.

measured at -6dB on the response curve (see Fig. 1). But the shape of the pass-band response determines a lot of the receiver's selectivity performance. In Fig. 1, the -6dB bandwidth (BW) is $f_2 - f_1$, centered on the design frequency, f_c . But note the slopes—they are broad and sloppy. When you look at the bandwidth at -60dB ($f_4 - f_3$), the numbers are much broader.

In Fig. 2, however, the filter that sets selectivity has a sharper cutoff, so the -60dB bandwidth is much smaller than before. Because of the -60dB bandwidth difference, the filter of Fig. 2 will generally outperform the previous filter (Fig. 1). That attribute of filters is sometimes specified by the filter shape factor, by comparing the -6dB and -60dB bandwidths as a ratio. Receivers with mechanical filters typically more nearly fit the model of Fig. 2, while some cheaper radios with ceramic filters more nearly match Fig. 1. The difference between Fig. 1 and Fig. 2 is also one reason for the difference in price between low-cost crystal filters and higher cost filters. I've seen prices from \$49 to \$210 for 9-MHz SSB and CW crystal filters; it's the shape factors that differ.

The dynamic range and third-order intercept refer to the ability of the receiver to handle large ranges of signals. Having a sensitivity so great that it will pick up a breath of hot air is of no use whatever when the receiver's dynamic range is so poor that it will "mush out" when strong local signals are received. The dynamic range is usually specified in terms of decibels between the minimum detectable signal (MDS) and the largest signal that can be handled. Note: *Dynamic range* is not the same as *automatic-gain control range*.

Some receivers improve dynamic range artificially by placing attenuators in the signal path, either in the front-end or in the IF amplifier. Some are switch selectable, while others kick in automatically. Generally speaking, the attenuator is nice to have, but only if it doesn't mask a lack of true dynamic range.

A preamplifier can be used ahead of the receiver to improve sensitivity; but, if the receiver lacks dynamic range, then there is no preamp that can help. Also, if the noise floor is too high (as it might be above 2-meters), then the preamp must be either low-noise or turned off.

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SCANNER SCENE

By Marc Saxon

Scanning Under Fire



With 200-channel scanning and wide-spectrum coverage, the Realistic PRO-2032 lets users monitor plenty of activity.

Realistic's PRO-2032 is one of the company's new desktop scanners. It's designed for base or mobile use by the operator interested in keeping track of a lot of activity. The PRO-2032 offers 200-channel scanning and covers a lot of spectrum.

The frequencies that this buckaroo can inhale are 30–54 MHz, 137–174 MHz, 380–512 MHz, and 806–960 MHz (minus the cellular bands). Coverage is also provided in the 109–137-MHz aeronautics band. Those frequencies can be entered in ten 20-channel memory banks, plus ten additional monitor channels. The scanning rate is 25 channels per second, but that can be slowed to eight channels per second. The PRO-2032 will search at 50 channels per second, or the slower speed can be selected.

Peeking inside the cabinet, we found IF's of 455 kHz and 10.7 MHz. The selectivity is -6 dB at ± 10 kHz; -50

dB at ± 20 kHz. The PRO-2032 offers $1.0 \mu\text{V}$ sensitivity on all bands except the aeronautics and the 800-MHz bands, where the sensitivity is $2.0 \mu\text{V}$.

Standard features include priority channel, lockouts, scan delay, direct search, and a headphone jack. The PRO-2032 comes ready to operate on 117 VAC. A 12-VDC power cord is available as an option.

HOT NEWS

The vivid images of the terrible wildfires that roared through areas of southern California not long ago are still fresh in everybody's mind. As we all know, forest fires can (and do) happen in any area of the country. Besides the manpower, water/chemicals, and fire-fighting equipment required to control major forest fires, communications are needed. If you're within monitoring range, you can pick up the action on your scanner.

Obviously, check out all local, county, and state fire and forestry-conservation frequencies that would normally be used in the fire ground area. Also monitor frequencies known to be used by area rescue and ambulance services.

If the fire is large and widespread, or is on federal land (national forest, national park, etc.), the U.S. Department of Agriculture's Forestry Service fire specialists will be on the scene.

Communications are needed to coordinate the

efforts of local agencies and the USDA firefighters. In states west of the Mississippi River, that takes place on 170.425, 170.575, 171.475, 172.225, and 172.375 MHz. In the eastern states, they use 170.475, 171.425, 171.575, and 172.275 MHz. USDA helicopters and fixed-wing fire-fighting aeronautical operations are reported between 118.825 and 120.0 MHz, 122.75, 122.8, 122.85, 122.9, 122.95, 123.05, 123.075, 166.675, 169.15, 169.20, and 170.00 MHz.

For other USDA fire frequencies that might produce activity, we suggest that you scan the band between 168.00 and 168.70 MHz. Also try monitoring 414.65, 415.40, and 415.50 MHz.

A LITTLE OF EVERYTHING

From Reno, Nevada, a note from April Pederson tells of several frequencies in use at John Asquaga's Nugget Casino. It appears that the messages going out are intended to be received by employees moving around in the casino. Jackpots are mentioned, as are reports of amounts being bet at certain tables.

A reader from Tennessee, who requests anonymity, reports that helicopters of the Tennessee Drug Task Force communicate on 154.77 MHz while searching for marijuana patches.

NOAA weather satellites operate on several fre-

quencies. Insofar as scanner users are concerned, 137.50 and 137.62 MHz are the channels of interest. We have run those frequencies here a few times in the past, and several inquiries have come in requesting additional information on the specifications of the satellite transmissions.

Maximum modulation is 4 kHz and the deviation is ± 18 kHz. The Doppler shift is ± 3 kHz, taking into account receiver and transmitter errors. METEOR satellites (on 137.06, 137.12, 137.15, 137.3, 137.33, 137.4, 137.45, 137.8, and 137.85 MHz) are alleged to operate with ± 10 -kHz deviation.

The standard scanners that most people use are designed for only NFM (± 15 -kHz bandwidth) and are sometimes also for WFM (± 150 -kHz bandwidth). Those bandwidths are intended primarily for optimum reception of either two-way communications or FM broadcast signals. Neither bandwidth is suitable for use by diligent satellite experimenters. However, for the casual monitoring hobbyist, a standard scanner with a good outside antenna should be able to produce some sort of gurgle or bleep to acknowledge that a satellite has been received.

SKIP SEASON, AHoy!

The approaching spring/summer season means renewed DX activity on the 30–50-MHz band. Here are some frequencies to watch, based upon the reported experiences of other monitors: Portuguese has been heard on 40.14, 40.16, 40.18, 40.20, 40.22, 40.40, 40.82, and 45.345 MHz; German on 31.25, 32.15, and 38.74 MHz; Turkish on 34.125 and 34.235 MHz;

and Spanish on 41.68, 45.18, 45.21, 45.48, 46.35, 46.50, and 49.50 MHz.

As a general rule of thumb, this type of seasonal Sporadic-E DX follows the sun. That means that it brings in stations east of your location in the morning, south of you during the middle of the day, and it works its way further west as the day wears on into the late afternoon.

This type of DX is characterized by DX stations in a particular area suddenly fading in, staying for a while, and then leaving very abruptly. In ten minutes, they could all return again!

You might be surprised to hear stations in Central and South America blasting through so loudly that they knock out stations in your local area. But remember, Spanish-language stations can just as easily be in the U.S. as anywhere else. Similarly, French-language stations might be coming from Louisiana or Quebec. Take nothing for granted.

You will also hear distant North American stations coming through, which gives you a break. The majority of them speak English, making it easier to identify them.

SEE YOU NEXT MONTH!

We look forward to your letters, questions, loggings, and comments. Our address is *Scanner Scene*, Popular Electronics, 500-B Bi-County Blvd., Farmingdale, NY 11735.



"He really loves that aviation receiver."

THINK TANK

(Continued from page 28)

should be a very simple circuit. I just want to make an LED blink on and off. It had been a year since I had used a 555, and I decided I would pull out the breadboard and a few parts and put together an astable multivibrator. Though I'm not great with electronic theory, I can usually put projects together from schematics with a good rate of success. However, at the end of a rather frustrating evening, I had fried three 555s and never got a blink. I used each of the schematics that I have included here (see Fig. 2), each coming from a different source. All three are a bit different in some way. Are any of these correct?

By the way, the circuit in Fig. 2A resembles the one that appeared in the October, 1991 issue of *Think Tank*. Did the various publications that I have made mistakes? Can 555 astable circuits be wired in various ways? What's the scoop on using this chip?

—Garry D. Cook,
Winston-Salem, NC

The third circuit (Fig. 2C) is a guaranteed chip eater because there's no current-limiting resistor for the LED. One thing that bothers me about the other circuits is the low value of their current-limiting resistors; they should be about twice the value that you have indicated. That might be keeping the chip from operating correctly. The last thing that occurs to me is perhaps you miscounted the IC pins (if that's so, don't feel too bad, it often happens). Remember, start at the pin nearest the dot (or to the left of the end-notch with the notch pointed upward) and count counterclockwise.

A CORRECTION

My turn-off delay circuit that you published in *Think Tank* in the April, 1993 issue of **Popular Electronics** had one error in the text. Resistor R1 in the revised circuit is referred to as 500 ohms, 5 watts. It should be 5000 ohms, 5 watts. The schematic, showing 5K ohms, was correct.

Shortly after mailing the circuit to you, I saw the possibility of a problem in that circuit. Because of the lack of a power transformer, the voltage across C2 (see Fig. 3) could rise rather high if there is no load (an open in R2 or between pins 1 and 2 of U2). Because of that, I connected a Zener diode (D2) in parallel with C2 to keep the voltage down. My C2 had a rating of 16 volts, so I used a 15-volt, 1-watt Zener diode.

—William Stiles, Hillsboro, MO

Thanks for the correction. Glad to pass it along.

That's all for this month's Q&A session. Until next month, please send your circuit ideas, questions, and topic ideas to me here at *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. If your letter appears here, you'll receive a *Think Tank II* or other book. ■

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CIRCUIT CIRCUS

(Continued from page 80)

uses two low-cost IC's—a 555 oscillator/timer and a 7805 5-volt 1.5-amp voltage regulator—to produce a voltage calibrator for your oscilloscope. In that circuit, the 555 oscillator/timer (U1)

is configured as a 250-Hz squarewave oscillator. The oscillator's output at pin 3 is fed to the input of a 7805 5-volt regulator (U2). The regulator's squarewave output, in turn, is fed to a voltage divider (comprised of five 1K, 1% resistors). Taps on the divider provide five output-voltage levels, rang-

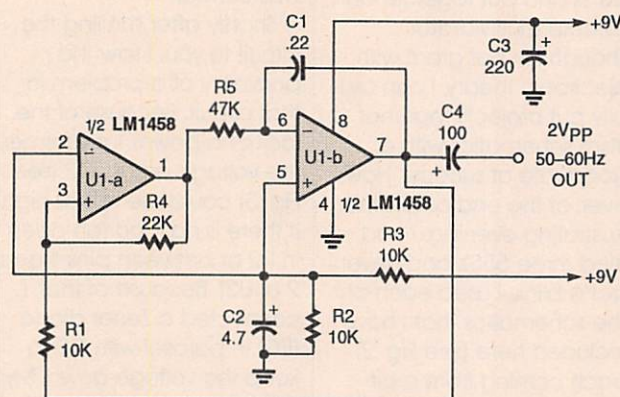


Fig. 5. This oscillator, which is built around a LM1458 dual op-amp and a few inexpensive components, produces a 2-volt peak-to-peak, triangular waveform.

PARTS LIST FOR THE TRIANGULAR WAVEFORM GENERATOR

RESISTORS

(All fixed resistors are 1/4-watt, 5% units.)

R1-R3—10,000-ohm

R4—22,000-ohm

R5—47,000-ohm

CAPACITORS

C1—0.22-μF, ceramic-disc

C2—4.7-μF, 16-WVDC, electrolytic

C3—220-μF, 16-WVDC, electrolytic

C4—100-μF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

U1—LM1458 dual op-amp, integrated circuit

Perfboard materials, enclosure, 9-volt power source, wire, solder, hardware, etc.

ing from 1- to 5-volts peak-to-peak. The circuit can be operated from any DC source of 9 to 12 volts.

MINI-MEGAPHONE

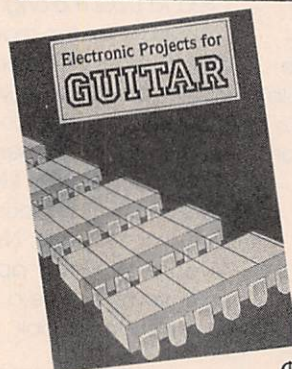
Our next circuit (see Fig. 4) is a mini-megaphone that's comprised of an elec-

tret microphone (MIC1), an LM386 low-voltage audio-power amplifier (U1), a horn speaker (SPKR1) and a few other components. All of the parts (including a suitable plastic enclosure for the circuit) can be purchased from Radio Shack. The circuit is non-critical so just about any construction scheme should work.

TRIANGULAR WAVEFORM GENERATOR

The next circuit came about when a low-frequency triangular-waveform generator was needed to complete a special audio test. A single LM1458 dual op-amp and a few inexpensive components connected as shown in Fig. 5 did the trick.

The output frequency can be varied by changing the value of R5; changing the value of C1 will shift the circuit's frequency range. Increasing the value of C1 will lower the oscillator's frequency and reducing the value will increase the frequency. Resistor R4 can be varied to change the output level. Powered from a 9-volt supply, the circuit produces a 2-volt peak-to-peak, triangular, output waveform.



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LAUNCH CONTROL

(Continued from page 43)

ring terminals of the phono plug, and then install the sleeve.

Finally, fasten the printed-circuit board to the enclosure using a 1-inch length of double-sided foam tape between the bottom of the printed-circuit board and the inside of the enclosure. That is easier than using mounting hardware, and it gives a neater overall appearance.

Test and Use. Set S3 to the 30 s position, S4 to the TEST position, and install 4 AA alkaline batteries in the quad battery holder. Attach an engine igniter to the 2 micro clips and insert phono-plug PL1 into jack J1; the test lamp, I1, should light. Now switch S4 to the LAUNCH position, turn on S1, and press S2, FIRE. The piezoelectric buzzer (BZ1) should begin to beep every few seconds. After about 30 seconds, the beeping stops, and the igniter fires.

Warning: Always pull the phono plug from its jack before attaching the micro clips to a live engine! Also **do not** allow the micro clips to short during a launch or test; otherwise transistor Q1 could be damaged.

Should any of the above tests fail, troubleshoot the circuit using a DC voltmeter. To do so, attach the meter's negative probe to ground, turn S1 on, and measure the voltage at pin 8 of each 555 timer—you should get a reading of approximately 6 volts. If so, check the voltage at pin 3 of U1, and then press S2. The voltage should remain near 6 volts during the time-delay interval and then go to zero. Similarly, at pin 3 of U2, the voltage should be at 6 volts for approximately one out of every 4 seconds. At pin 3 of U3, it should change from zero to 6 volts at the end of the time delay, and then return to zero. If any of those tests fail, recheck all solder connections and component values associated with the defective timer.

The Time-Delayed Launch Control makes a great weekend project. Since all of the parts are inexpensive and come in a variety of shapes and sizes, the control panel can take on a customized look, limited only by your imagination. So heads up and happy flying!

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DISTINCTIVE RING SWITCH

(Continued from page 36)

The other three jumpers work in an identical manner for two rings, three rings, and four or more rings per ring cycle.

Figure 6 shows the jumper settings for a typical setup where the phone is connected as device 1 and a fax machine is connected as device 2. The jumper settings shown will leave the incoming line connected to the telephone if one ring is detected in a ring cycle. For more than one ring per ring cycle, the fax machine will be connected to the incoming line. Consecutive ring cycles are separated by at least one second without any ringing.

When the Distinctive Ring Switch is powered up and attached to the incoming phone line, the red LED for device 1 should be lit. Adjust the jumpers to your desired configuration and have a friend call the phone number for device 2. After the first ring cycle, the green LED for device 2 should indicate that the incoming line has been switched. When you hang up the phone, the LED's should change back to the device-1 display.

Now have your friend call your de-

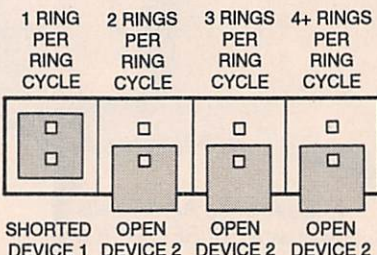


Fig. 6. Shown here are the jumper settings for a typical setup where a phone is connected as device 1 and a fax machine is connected as device 2. The jumper settings shown will leave the incoming line connected to the telephone if one ring is detected in a ring cycle. For more than one ring per ring cycle, the fax machine (device 2) will be connected to the incoming call.

vice 1 number to make sure that device 2 is not selected by a device 1 ring pattern. The red LED for device 1 should remain lit.

Operation. The Distinctive Ring Switch leaves device 1 connected to the incoming phone line when there

is no phone-line activity. That allows a telephone or other device connected as device 1 to make outgoing calls. Note that a telephone connected as device 2 would not have a dial tone. It would only be connected to the incoming line when the proper ring pattern is detected. When the first ring occurs, device 1 receives a ring signal. The first ring always goes to device 1 while the Distinctive Ring Switch analyzes the ring pattern. A phone connected as device 1 will ring to alert you that a call is coming in and you will be able to distinguish between normal and distinctive rings as usual.

Any device connected as device 1 should be set to answer after two or more rings. If a device-2 ring pattern is detected, the incoming line is immediately switched to device 2. If device 2 answers the call, the Distinctive Ring Switch monitors the call status. As soon as device-2 concludes the call by hanging up, the incoming line is switched back to device 1. Sometimes the calling party hangs up before device 2 answers. The Distinctive Ring Switch detects these unanswered calls by looking for 4.5 seconds without a ring signal while device 2 is still on hook. As soon as it senses an unanswered call, it switches the incoming line back to device 1.

By correctly setting the ring-detect jumpers, it's even possible to configure multiple Distinctive Ring Switches to switch to more than two devices. That would only be useful if your local telephone company is one of those that will assign more than one distinctive ring number to a single line.

Whether you are switching between two answering machines, adding a fax machine or BBS to your regular line, or have another application, the Distinctive Ring Switch will give you the ability to automatically route calls. Best of all, you can now add the convenience of a second phone number without spending a fortune on a separate line. ■



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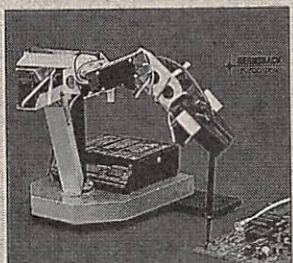
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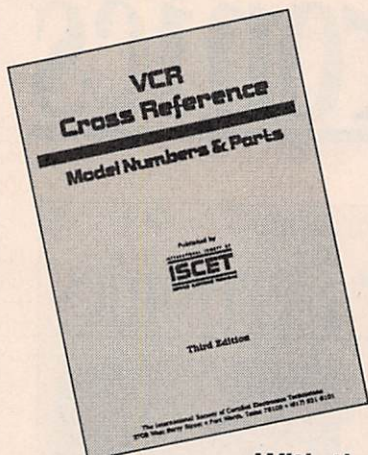
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DOCUMENTATION

(Continued from page 40)

represent groups of components. The simplified presentation helps one to visualize the relationships between the various stages of a complex circuit. The block diagram for a stepped-waveform generator is shown in Fig. 8. In the block diagram, as in schematics, the signal flow is from left-to-right and top-to-bottom. The blocks are ideally all the same size and the direction of signal flow is shown with arrows on the interconnecting lines. Conventional schematic symbols for the adjustable elements are sometimes shown outside the blocks to add clarity.

As we said at the beginning, this is by no means an in-depth treatment of documentation. My only desire is to inspire you to write down all those details that come up while you are designing and building your projects. There is no absolute right way and wrong way to do it. If you and others you show the documentation to can understand it, you are obviously doing something right. ■

FIELD EFFECT TRANSISTORS

(Continued from page 74)

CMOS Technology. An enhancement MOSFET can act as a switch when it is turned on or off by a voltage applied to its gate; N-channel devices are switched on by a positive gate voltage, but P-channel devices are switched on by a negative gate voltage. That symmetry of operation is known as a "complementary response," and forms the basis for the CMOS (or complimentary MOS) logic family. That IC family is, of course, sensitive to electrostatic discharge.

Figure 7A shows a cross-sectional view of a complementary pair of MOSFET's implemented on a common substrate. The common substrate used for that pair is N-doped silicon material (or "wafer"). Implementing an N-channel MOSFET on an N-type substrate requires the defusing or implanting of a P-doped well in the substrate. The smaller N-type well is then formed in the P-doped region.

Because the substrate is N-doped, fewer steps are required to form the P-channel FET. The P- and N-doped guard bands isolate and insulate the individual FET's to prevent mutual interference. Although not shown, the guard bands are actually N- or P-doped rings formed around the complete FET below the oxide layer.

Two complementary transistors can be connected to form an inverter (the simplest of logic gates). The complementary arrangement is accomplished by connecting the gates of the two MOSFET's together to form a single input (V_{in}) terminal, and taking the output from a common drain. One source (the P-channel) of the complementary pair is connected to V_{dd} while the other source terminal is connected to V_{ss} (as shown in Fig. 7B).

With no gate bias applied to the complementary pair, the inverter offers a very high impedance path from the input to ground, therefore the output voltage rises to V_{dd} . When the input voltage is high (logical 1), the situation is reversed, the P-channel device is cutoff, and the N-channel unit is turned on, so the input voltage drops to zero. Thus, a logical-high input gives a logical-low output, and vice versa. In either logic state, one MOSFET is on, while the other is off. ■

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BEYOND OHM'S LAW

(Continued from page 68)

tively easy to calculate the voltage that will appear between points X and Y by using Ohm's Law. First we subtract the voltage sources (which oppose one another) to get the total voltage. Then we divide that voltage by the total series resistance to get the overall current (1.4 amps). Now, using Kirchhoff's voltage law, let's write the voltage we want (V_{TH}) in terms of the drops and sources of one of the current loops, say the one with B1 and R1:

$$V_{TH} = B1 + I_1 R1$$

We know I_1 , so:

$$V_{TH} = 21V + 1.4A \times 3 \text{ ohms} = 25.2V$$

With both batteries shorted out, the circuit resistance is simply R1 and R2 in parallel, which comes to 2.4 ohms (see Fig. 6C).

The Thevenin equivalent of the circuit is shown in Fig. 6D. If you are connecting different loads to points X and

Y, the equivalent circuit will behave in exactly the same way as the original. The advantage, of course, is that the calculations for each load resistor are much simpler and quicker to perform. Try the Thevenin circuit with the original R3 value of 6 ohms, and you will get a current of 3 amps.

Norton's Theorem. A network can also be simplified by using Norton's Theorem. The principle involved is very similar to Thevenin's Theorem, but instead of a constant-voltage source and series resistance, the Norton method uses a constant-current source with a parallel resistance.

To keep matters simple, we'll continue to use the same circuit as in Fig. 6A. Recall that to obtain the Thevenin equivalent you must calculate the open-circuit voltage between points X and Y. To determine the value for the constant-current source of the Norton circuit, the short-circuit current must be calculated (Fig. 7A). Shorting X and Y in the example shown results in 7 amps flowing from B1 through R1, and

3.5 amps flowing from B2 through R2, giving a total short-circuit current of 10.5 amps. The Norton parallel resistance is calculated in exactly the same way as for the Thevenin conversion: Just work out the resistance between points X and Y when all voltage sources are shorted out.

The Norton equivalent circuit appears in Fig. 7B. When nothing is connected to points X and Y, the full 10.5 amps from the constant-current source must pass through the 2.4-ohm parallel resistance. Connecting a load to the circuit causes the current to split proportionally.

In the case of the original 6-ohm resistor, the total parallel resistance comes to approximately 1.7 ohms. Since the constant-current source of the Norton circuit always supplies 10.5 amps, no matter what the circuit resistance, the voltage appearing across the load can be calculated with Ohm's Law to be 18 volts. Another application of Ohm's Law will tell you the current through the load, which is 3 amps. ■

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BUILD THE RELAY STATION

(Continued from page 70)

R4, and R6), a 40-kHz oscillator (the 555 and its timing components), an IR transmitter (R5, Q1, and LED1-LED3), and a power supply (the rest of the circuitry).

Taking the power supply first, the current source is a 9-volt battery that is switched on by S1. Its output is limited by R3, and voltage regulated down to 4.8 volts by D1 and D2. The regulation is necessary to reduce the voltage to a level that MOD1 can handle. It has the added advantage of allowing us to connect the three IR LED's in series without using a dropping resistor, which would dissipate power but do no useful work.

While the oscillator circuit is based on a 555 timer, that IC is used in a non-standard configuration. Normally, D3 would not be present. Without it, C1 (the oscillator's timing capacitor) would charge through R1 and R2, and discharge through only R2. Therefore, it would discharge faster than it would charge. Since the 555's output goes high as the capacitor charges and low as it discharges, the output would not be high for the same amount of time that it is low. In other words, its duty cycle would not be 50%, which is needed for this application.

With D3 in the circuit, R2 is bypassed (or shorted out) while C1 is charging, but is in the current path during discharge. Therefore, by making R1 and R2 equal, the charge time equals the discharge time, yielding an output with a 50% duty cycle. Components R1, R2, and C1 (all precision, drift-free units) have been chosen to provide a 40-kHz output in this configuration. That output strobes the IR LED's via Q1.

However, the oscillator only functions when pin 4 of the 555 is high. Since that pin is connected to the inverter circuit, the oscillator functions when the inverter's input is low. The inverter's input is connected to MOD1's output, which goes low with each remote burst received. So overall, the circuit produces a 40-kHz IR burst when it receives one.

Construction. Building this project is very easy. That's because it uses very few components to do its job, and they can all be purchased from Radio

Shack. My circuit was constructed using point-to-point wiring of three assemblies: the module plus inverter, the IR-LED chain, and the rest of the circuit (which was placed on a "main board").

The assemblies were installed in a metal cabinet to reduce RF interference. If you'll just be using the unit as a repeater for long or well-lit rooms, the IR assembly and the module should face out through opposite surfaces of the cabinet. If you'll use the unit as a repeater to broadcast signals around corners, the IR assembly and the module should be on adjacent surfaces of the cabinet. Keep that in mind when laying out your own unit. One unique way of accommodating both situations would be to make a swivel mount for the module out of an old film canister. It could be attached to a surface adjacent to that of the LED's via a screw in the canister's cap, and rotated to face any desired direction.

The inverter's components (Q2, R4, and R6) were mounted directly onto the module by soldering their leads right to the module's pins. The module's ground pin was also connected to its case. That is a must for reducing RF interference, which would make the unit buggy. Three wires were then attached to pertinent points in the assembly (V+, ground, and the inverter's output) and run to the main board. The module face was then attached to the case with a piece of double sided foam, allowing it to peer through a hole made in the cabinet.

The IR LED's were mounted on a piece of vector board by themselves. They were wired together in series and the two remaining LED leads were attached to wires that connect the assembly to the main board. Another piece of vector board was used as a drilling template to make holes in the case to accommodate the LED's. The LED assembly was pushed into position through the cabinet face. Then a hole was drilled through the board and case to accommodate S1. The switch was passed through the holes and fastened, which holds the LED board in place. The switch was then wired to the battery clip and main board.

The remaining components and battery-clip lead were connected to the main board (a small piece of ex-

perimenter's board). The board and a fresh battery were mounted in the enclosure with double-sided foam. The battery clip was then snapped on the battery and the case was closed.

Since there's nothing to adjust, if you've wired your unit properly it should be ready to work as soon as you switch S1 on. To test the circuit, try to hide your remote control and the detector side of the Relay under some newspapers. Make sure the Relay is off and check to ensure that the remote cannot operate anything from under the paper. If it still controls anything, shuffle the papers around until the equipment no longer receives responses from the remote. Switch the Relay on and activate the remote. If everything is working as it should, all your components should respond normally to the signals being re-broadcast by the Relay.

If something's amiss, disassemble the unit. Fire a remote at the detector and using a multimeter or oscilloscope look for a digital signal at the detector-module's output. If there is none, you've got a faulty module, or you've incorrectly wired it to the inverter. If MOD1 is fine, check the inverter's output. Its output signals should be the compliment of the signals from MOD1. If not, check your inverter's wiring. If that's fine, check pin 3 of U1 for 40-kHz bursts while operating the remote. A lack of signal there indicates an oscillator problem. If all is well, check for pulsed current flow through the IR-LED chain. A lack of current there could only be the result of a bad Q1, a bad LED, or miswiring.

Hopefully this circuit will add more freedom to your use of remotes. Unlike many of the manufactured alternatives, its low-cost, safety, and ease-of-use should make it a really big hit with the family, too. ■



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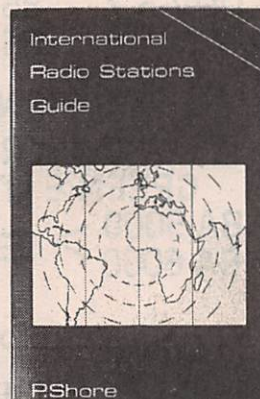
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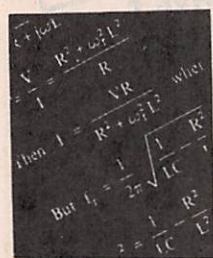
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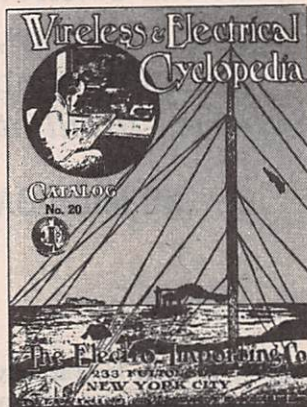
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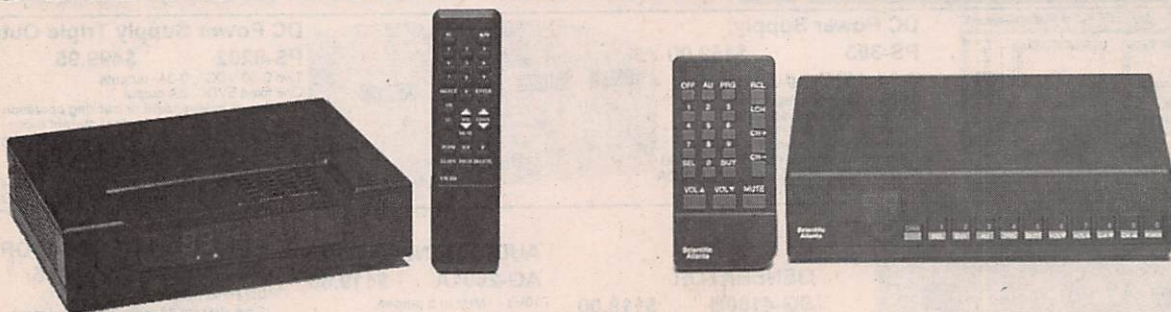


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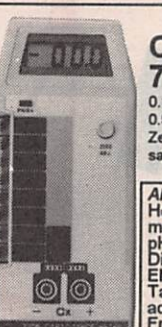
Inductance: 0.1μH-200H
Capacitance: 0.1pF-20,000μF
Resistance: 1mΩ-20MΩ
1% basic accuracy
Dissipation factor indicates leakage
Zero adjustment to reduce parasitics
from test fixture
Best for high frequency RF
and surface mount components.
SMD and chip component test probe
\$25.00, Deluxe carrying case \$5.00



LCR Meter 195 \$119.95

Very Popular LCR

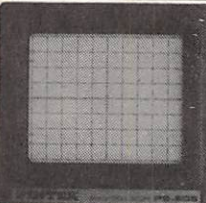
Inductance: 1μH-200H
Capacitance: 0.1pF-200 μF
Resistance: 0.01Ω-20MΩ
Basic accuracy: R:1%, C:2%, L:3%
Test frequency 1 kHz
Soft carrying case \$3.00
Deluxe case \$5.00



Capacitance Meter 7705 \$57.95

0.1 pF-20,000μF in 9 ranges
0.5% basic accuracy
Zero adjustment ± 20pF to compensate
parasitics from test fixture

Also Available:
Heavy duty DMM, AC/DC clamp
meter, Thermometer, Light meter
pH meter, High voltage probe
Digital caliper, Anemometer
Electronic scale, Force gauge
Tachometer, Humidity & EMF
adapter, Sound level meter
Frequency counter, SWR/field
strength/power meter, Dip meter



20 MHz Oscilloscope with Delay Sweep PS-205 \$429.95

Dual Trace, Component test, 6" CRT, X-Y Operation, TV
Sync, Z Modulation, CH2 Output, Graticule Illum, 2 probes
each has x1, x10 switch. Best price with delay sweep.
PS-200 20 MHz DUAL TRACE \$339.95
PS-400 40 MHz DUAL TRACE \$494.95
PS-405 40 MHz DELAY SWEEP \$569.95
PS-605 60 MHz DELAY SWEEP \$789.95

20 MHz Digital Storage Oscilloscope DS-203 \$729.95

Switchable between digital and analog modes
2 K word per channel storage
Sampling rate: 10 M sample/sec
8 bit vertical resolution (25 Level/div)
Expanded Timebase 10ms/div - 0.5 s/div
Refresh, Roll, Save all, Save CH2, Pre-Trig
Plotter Control



DC Power Supply PS-303 \$159.00

0-30 VDC, 0-3A output

0.02% + 2mV line regulation
0.02% + 3mV load regulation
1 mVrms noise and ripple
Short circuit and overload protected
PS-8200 with digital voltmeter \$179.00
Also available: 30V/5A, 60V/3A, 60V/5A
16V/10A, 30V/10A



DC Power Supply Triple Output PS-8202 \$499.95

Two 0-30 VDC, 0-3A outputs
One fixed 5VDC, 3A output
Capable of independent or tracking operation
Constant voltage and constant current mode
Four digital meters for volt and current display
Excellent regulation and low ripple
Short circuit and overload protected
Also available: 30V/5A, triple output \$549.95
60V/5A dual tracking \$749.95



RF SIGNAL GENERATOR SG-4160B \$119.00

100 kHz-150MHz sine wave in 6
ranges
RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz
AM modulation
Audio output 1 kHz, 1 Vrms



RF SIGNAL GEN./COUNTER SG-4162 AD \$229.95

Generates RF signal same as SG-
4160B
Frequency counter 1Hz - 150 MHz
for internal and external source
Sensitivity <50mV

AUDIO GENERATOR AG-2601A \$119.00

10Hz - 1MHz in 5 ranges
Output: 0-8Vrms sine wave
0-10Vp-p square wave
Synchronization: ±3% of oscillation
frequency per Vrms
Output distortion:
0.05% 500Hz - 50kHz
0.5% 50Hz - 500kHz
Output impedance: 600 ohm

AUDIO GEN./COUNTER AG-2603AD \$229.95

Generates audio signal same as AG-
2601A
Frequency counter 1Hz-150MHz
for internal and external sources
Sensitivity <50mV

FUNCTION GENERATOR FG-2100A \$169.95

0.2 Hz - 2 MHz in 7 ranges
Sine, square, triangle, pulse and ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control frequency to 1000:1

FUNCTION GEN./COUNTER FG-2102AD \$229.95

Generates signal same as FG-2100A
Frequency counter 4 digits
Feature TTL and CMOS output

SWEEP FUNCTION GEN./COUNTER \$329.95

0.5Hz to 5 MHz in 7 ranges
Sweep: Linear 10:1/Log 10:1 20ms to 2s
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Generator Control Voltage & 8 digit counter
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Brand new—original box—3 1/2" x 2" x 3/4"
\$40.00 Value — Southpaw Special **\$7.50 each**

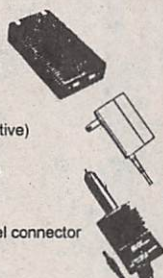
2 - PLUG-IN POWER SUPPLY

Input 120VAC Hz—Output 8VDC @ 1AMP
6' cord with 2.1mm barrel connector (center positive)
Ideal for charging Ni-Cad Pak
\$12.00 Value — Southpaw Special **\$3.75 each**

3 - IC REGULATED DC ADAPTOR

DC to DC—Input -12VDC/Output 8.5VDC
Cigarette lighter plug to 6' cord with 2.1mm barrel connector
Ideal for charging Ni-Cad Pak
\$7.95 Value — Southpaw Special **\$3.50 each**

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• Full Ranging Input Voltages From 90 to 264 VAC

Will provide the necessary power and cable to run two drives - one hard drive and one floppy disk drive with a microconnector. Has its own internal fan capable of cooling power supply as well as the components inside the computer to a safe operating temp.

Output Voltages	Full Load (amp)
+5V	10.0 A
+12V	1.5 A
-12V	.3 A
-5V	.3 A

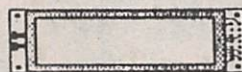
UL/CSA Approved
Size: L 6.5" x W 2.8" x H 3.7"

#PSB03 **\$24.95 ea.**



SHARP LM 16257

5x7 Dot Matrix Display W/Cursor
Intelligent 16 Characters x 2 Line

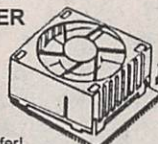


Character height .22", Supply voltage +5V,
Dot color - Dark Blue, Background - White,
On-Board CPU, RAM & ASCII, Character
Generator. Dimensions: 3 5/16" x 1 3/8" x
3/8". Full specs supplied.

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Spring loaded heat sink - assures maximum heat transfer!
Powerful 5500 RPM 12 VDC Fan Dual power plugs - fits all PC's. Individually boxed. #F486



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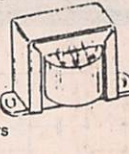
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General Purpose
American Mfr.
Primary: 115V 60Hz
Secondary:

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- #2 24VAC @ 4.0A
- 3 1/2" Mounting Centers
- H 2 1/2" x L 3" x W 1"

#PTR01

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Input: 115/230 VAC
Outputs: +5V @ 8A, +12V @ 2A
-12V @ 1.5A, 25.5V @ 3A
+18V @ .2A, 18V @ 2A

Size: L 9.5" x H 4.5" x W 1.75"

#PSB02 **\$29.95 ea.**



Standard G.P. Rectifier

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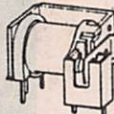
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10 Lots/\$2.50 ea.



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GB03	Ceramic Discs - 500
GB04	Connectors - 50
GB05	IC Sockets - 200
GB06	Trim pots - 100
GB07	Crystals/Oscillators - 20
GB08	Resistors* - 1500
GB09	Wirewound Resistors - 100
GB10	Relays - 20
GB11	Electronic Hardware - 2 lbs.
GB12	Transistors - 100
GB13	Zener Diodes - 200
GB14	Switches - 25
GB15	Fuses - 50
GB16	Volume Controls - 50
GB17	Heat Sinks - 25
GB18	IF Transformers - 200
GB19	Solderless Terminals - 150
GB20	Plug-in Adapters - 10
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*carbon film/carbon comp



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Red \$.06 ea. 20 piece
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Green \$.07 ea. per item



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Reds & Greens
25 Piece Assortment **\$9.95**

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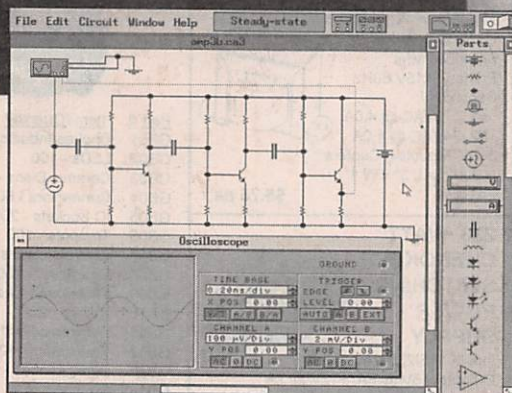
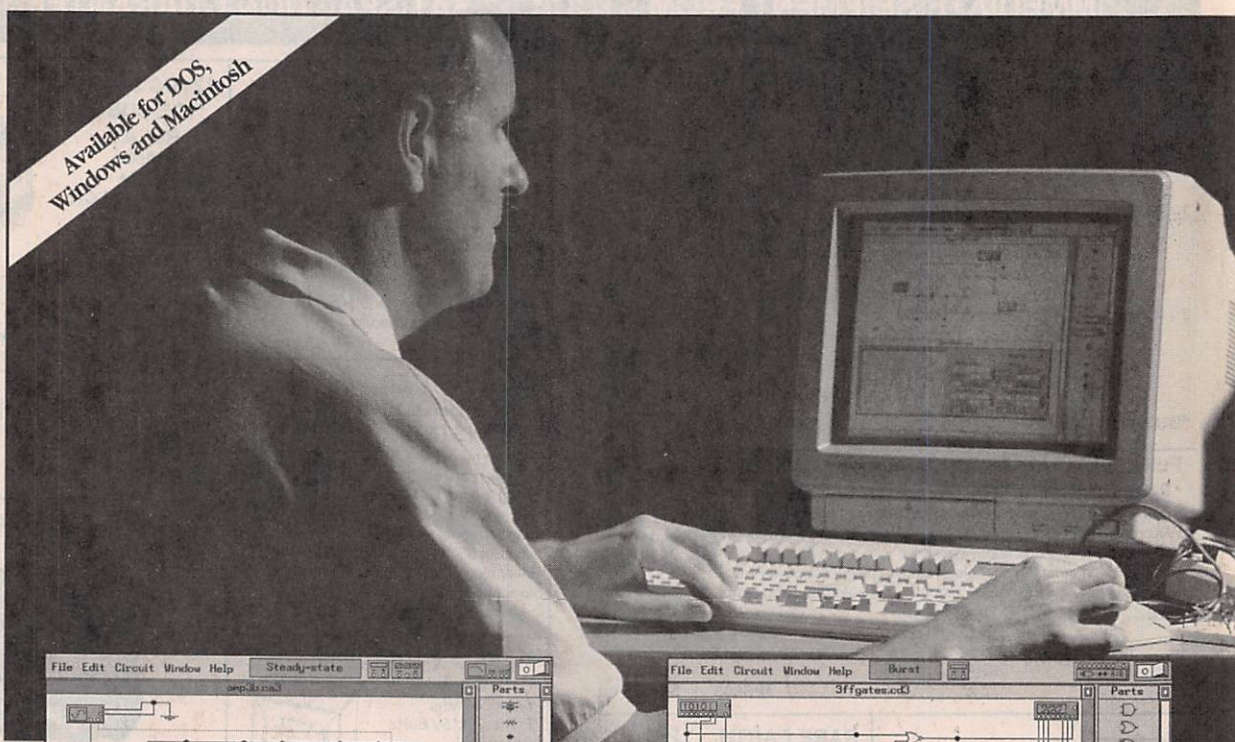
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- function generator (1 Hz to 1 GHz)
- dual-trace oscilloscope (1 Hz to 1 GHz)
- Bode plotter (1 mHz to 10 GHz)

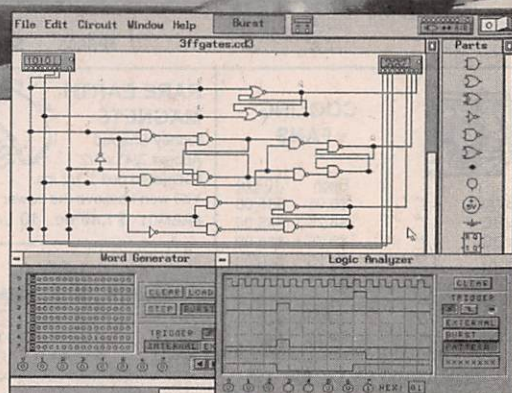
SYSTEM REQUIREMENTS

MS-DOS version: Requires IBM AT, PS/2 or true compatible with 286 or greater, hard disk, 1 MB RAM, Microsoft-compatible mouse, EGA or VGA display adapter and DOS 3.0 or greater. Supports a math co-processor if available.

Windows version: MS-DOS 5.0 or higher, Microsoft Windows 3.1, 2 MB RAM with suitable pointing device.

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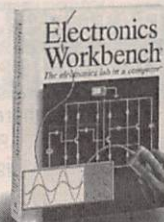
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Elenco's Digital/Analog Trainer is specially designed for school projects, with 5 built-in power
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■ +12VDC @ 1 Amp
■ -12VDC @ 1 Amp
■ +5VDC @ 1 Amp
■ 30VAC Center tapped
@ 15VAC at 1 Amp
Analog - Section
■ Function Generator Sine,
Triangular, Square wave forms
■ Frequency adjustable in five
ranges from 1 to 100KHz
■ Fine frequency adjust
■ Amplitude adjust
■ DC offset
■ Modulation FM-AM
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■ 2 breadboards, each contain:
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■ (-1.25 to -15VDC @ 1 Amp)
■ +12VDC @ 1 Amp
■ -12VDC @ 1 Amp
■ +5VDC @ 1 Amp
■ 30VAC Center tapped
@ 15VAC at 1 Amp
Analog - Section
■ Function Generator Sine,
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■ Frequency adjustable in five
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■ Fine frequency adjust
■ Amplitude adjust
■ DC offset
■ Modulation FM-AM
Digital - Section
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■ Two no bounce logic switches
■ 8 LED readouts TTL buffered
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■ Clock amplitude 5VPP square wave
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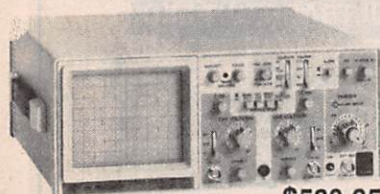
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- \$695.95**

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 - Dual time base
 - Calibrated delay time multiplier
 - Signal delay line
 - 19kV accelerating voltage
- \$1,395.95**

20MHz ANALOG

WITH DIGITAL STORAGE

- Model 2522A**
- 20MHz analog bandwidth
 - 20MS/s sampling rate
 - 2k memory per channel
 - 20MHz equivalent time sampling
 - Pre-trigger capture
- \$875**

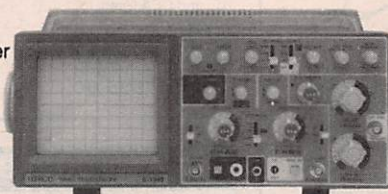
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**S-1360
Delayed Sweep
\$775**

**60MHz
Dual Trace**

**S-1365
Cursor Readout
\$849**

- Automatic Beam Finder
- Built-in Component Tester
- 1mV Sensitivity
- Dual Time Base
- Illuminated Internal Gradicule
- TV Sync



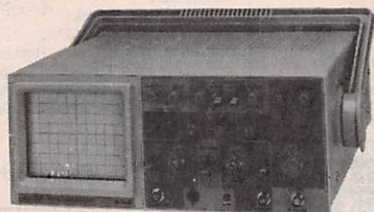
- Voltage, Time, + Frequency differences displayed on CRT thru the use of cursors.
- 1mV Sensitivity
- TV Sync

**S-1345
Delayed Sweep
\$575**

**40MHz
Dual Trace**

**S-1340
\$495**

- Automatic Beam Finder
- Built-in Component Tester
- 1mV Sensitivity
- Dual Time Base
- Illuminated Internal Gradicule
- TV Sync



- High luminance 6" CRT
- 1mV Sensitivity
- 12KV Acceleration Voltage
- 9ns Rise Time
- X-Y Operation
- TV Sync

**S-1330
Delayed Sweep
\$449**

**25MHz
Dual Trace**

**S-1325
\$349**

- Automatic Beam Finder
- Built-in Component Tester
- 1mV Sensitivity
- Dual Time Base
- Illuminated Internal Gradicule
- TV Sync



- High luminance 6" CRT
- 1mV Sensitivity
- 2KV Acceleration Voltage
- 18ns Rise Time
- X-Y Operation
- TV Sync

SPECIAL BUY HITACHI V-212



**20MHz
2 Channel**

\$399

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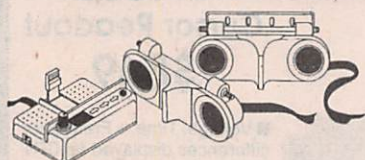
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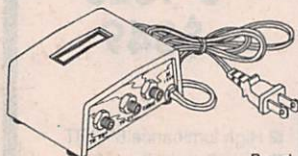
The ED-100 was designed for use as an auto/truck/RV back-up alarm. A digital display and audible beeper inside the vehicle inform the driver of the distance to impact beginning when the vehicle is within 14 feet of another object. Two 40 kHz ultrasonic emitter/detector modules, measuring 5.81" long X 1.9" wide, 2.05" thick, attach to the rear of the vehicle. The device operates on 12 or 24 Vdc.

These units are new, in original cartons and include instructions. The company that marketed this device is no longer in business, and no manufacturer's guarantee is in effect.

We offer these ultrasonic detectors for experimentation only, and in no way wish to promote their usefulness as a driving aid.

Originally sold for over \$100.00. **CAT# ED-100**
\$24.95 per set

EXPERIMENTER'S DELIGHT VHF TO UHF BLOCK CONVERTER



Channel Master #0746
This is one of those deals that's too good to be true.

Brand new, in the box, Channel Master block converters.

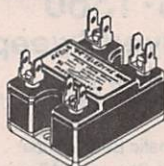
They used to be quite popular back in the early days of cable television, before there were a lot of cable-ready TVs. Somewhere in the world we know there is still a demand for them—especially at this price. Designed to convert television VHF channels 2 through 13 and A through W to UHF channels 36 through 76. The box alone, is a great project box. The 10 ft. AC power cord, the interior components, F connectors and AC receptacles are well worth the price.

CAT# CM-0746

10 pieces for **\$18.50**
\$2.00 each

10 AMP SOLID STATE RELAY

Teledyne Relays# 615-8500
Control voltage: 3-32 Vdc
Load: 10 amp, 250 Vac 50/60 Hz
Standard "hockey puck" size:
2.27" X 1.72" X 0.95".
Screw and qd/solder terminals.
UL and CSA listed.



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10 for **\$95.00**

CAT# SSRLY-14

240 X 128 DOT LCD DISPLAY

Optrex# DMF660N-S
240 X 128 dot LCD module with on-board drivers. Will display graphics, figures and characters.

Module size: 5.68" X 4.1" X 0.5" thick.

Viewing area: 4.1" X 2.52".

Dot size: 0.4mm X 0.4mm. High contrast, wide viewing angle. Low voltage drive and low power consumption. Uses fitting controllers LSIMS6255, HD64646, SED1330, SED1351. Includes hook-up instructions and specs.



CAT# LCD-15

\$29.95 each

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10 button, matrix encoded keypad. Peel-and-stick backing for easy mounting. Originally designed for use on a satellite TV tuner, the keys have satellite names and related text on them in addition to numerals 0 through 9. Overall dimensions are 9" X 1.625", but half of the strip can be cut off with a knife or scissors, leaving a self-sticking keypad of 4.5" X 1.625". Silver keys with charcoal numerals and background. 6.5" flexible ribbon cable, terminated with 7 pin socket connector - 0.1" spacing.

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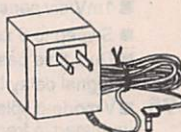


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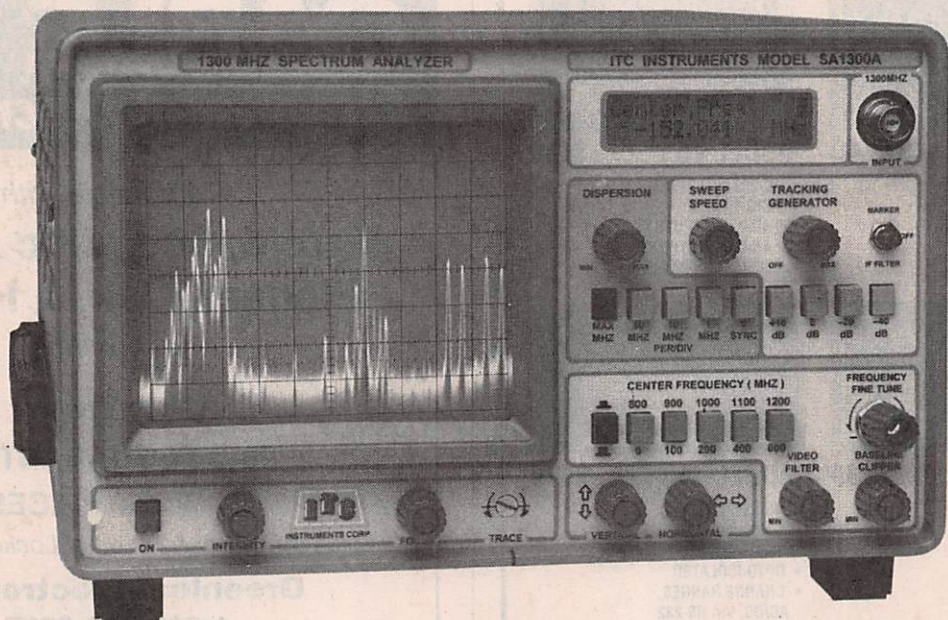
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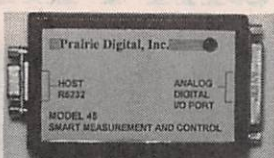
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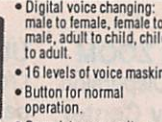
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- Digital voice changing: male to female, female to male, adult to child, child to adult.
- 16 levels of voice masking.
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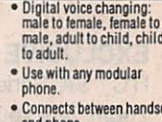
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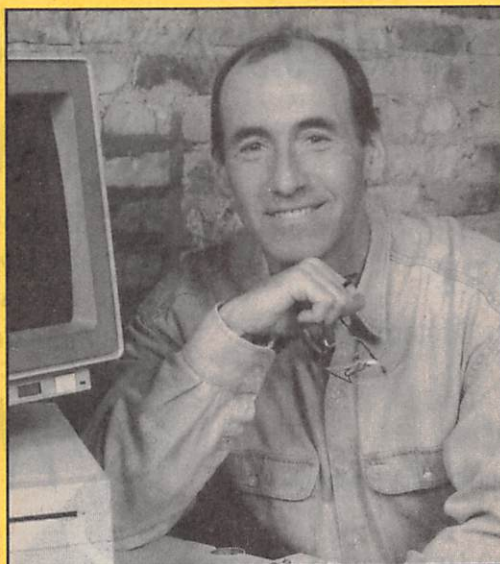
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The secret of the Fundamentals Method.

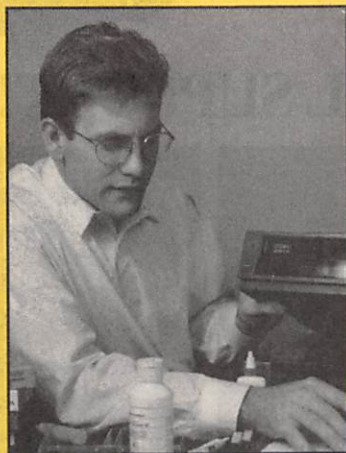
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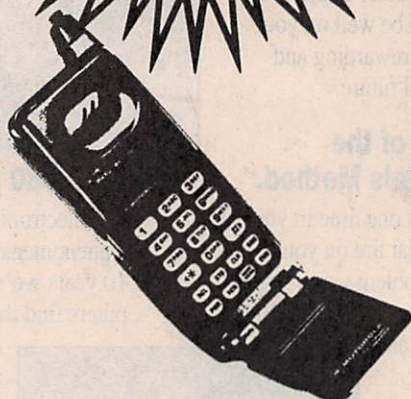
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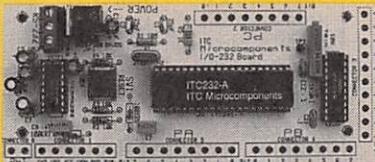
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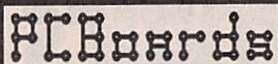


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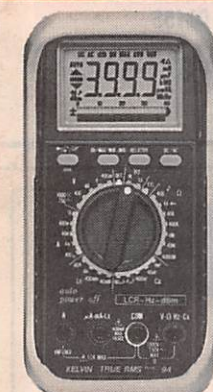
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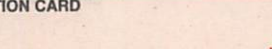
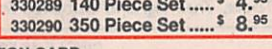
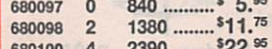


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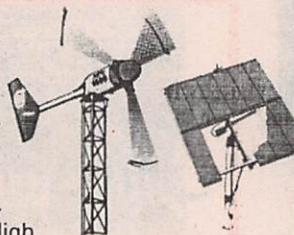
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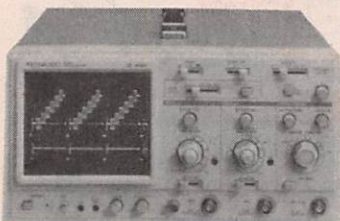
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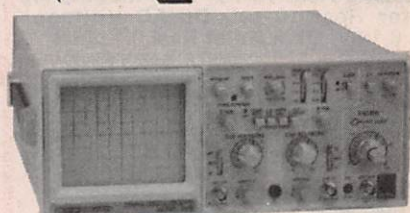
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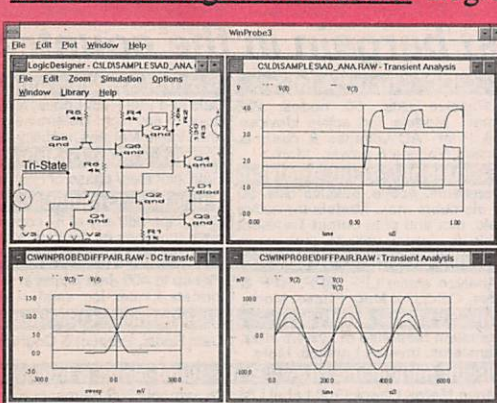
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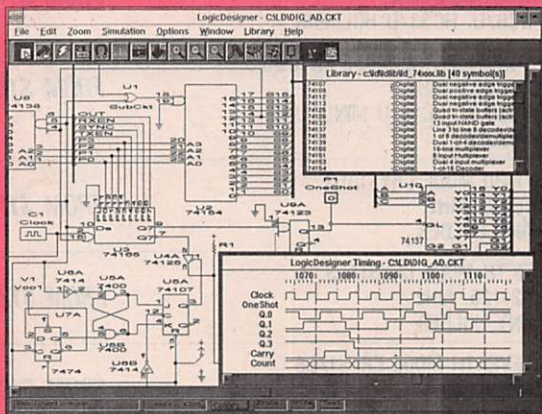
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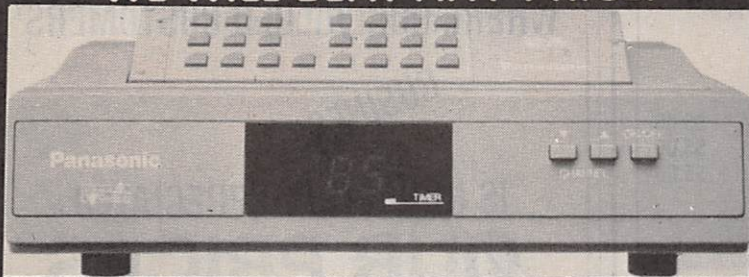
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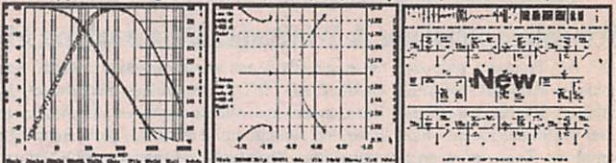
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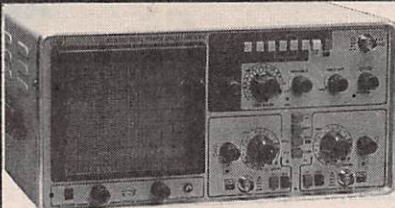
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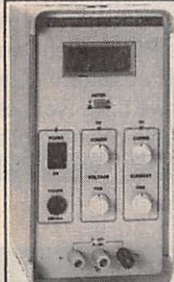
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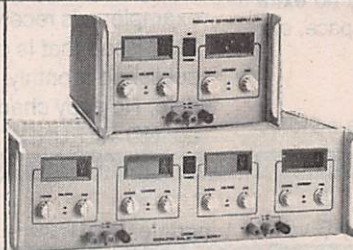
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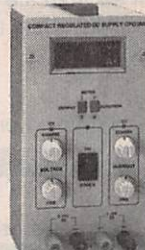


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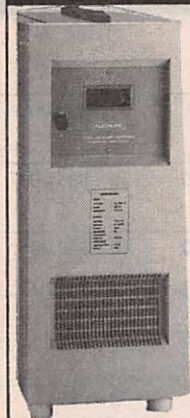


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Our classified ad rate is \$1.00 per word. Minimum charge is \$15.00

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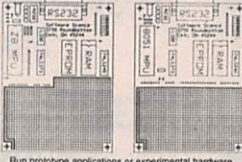
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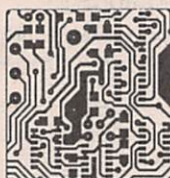
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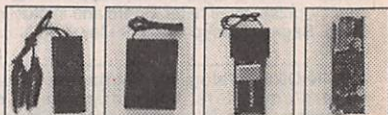
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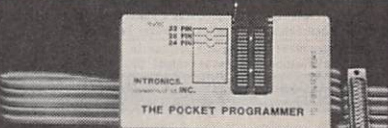
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Free Information No.	Page	Free Information No.	Page
— A&D Electronics	126	— ISCET	87
— Agrelo Engineering	114	139 ITC Instruments	107
26 Alfa Electronics	100	— ITC Microcomponents Inc.	113
28 All Electronics	106	37 Jan Crystals	118
— Allen Engineering	112	— JP Video	123
— Amazing Concepts	13	38 Kelvin Electronics	115
151 AMC Sales	5	— McGraw-Hill CES	31
— Andromeda Research	125	— M&G Electronics	122
— Antique Radio Classified	82	— Marymac Industries Inc.	122
— Asher Engineering	119	— MD Electronics	99
137 B&S Sales	98	— Mega Electronics	126
— C&C Specialties	124	— Modern Electronics	126
32 C&S Sales	104, 105	— Newtronics	125
— CBC International	82	— NRI Schools	11
— Cellular Link	114	— NuTek	81
— CIE	65	— Ohio Automation	122
— CLAGGK Inc.	18, 85	43 Optoelectronics	111
— CLAGGK Inc.	91, 94, 95	— PC Boards	113
— CLAGGK Video Offer	CV4	— PCW Technical Publications	126
— Command Productions	6	— Phillips Tech	124
— Communication Specialists	126	47 Prairie Digital Inc.	108
140 Compco	125	46 Print	116
— Consumertronics	113	— Progressive Concepts	125
13 Cook's Institute	27	— RC Distributing Co.	124
— Copyright Clearance Center	3	— RC Electronics	126
162 Davis Instruments	23	— Seattle Film Works	127
— EDE	125	— Self-Reliance Co. Inc.	116
— EIA	CV3	— Sil Walker	125
— Electronics Engineers BC	7	— Silicon Valley Surplus	126
— Electronics Technology Today	CV2	— Skyvision (Small)	122
— Electronics Technology Today	90	— Soft-Wear Productions	112
— Firestik II	81	— Software Science	122
— Foley-Belsaw Company	109	— Software Systems Consulting	87
— Fotronics	116	127 Southpaw Electronics	101
— Geoban Engineering	118	— Spy Supply	110
— Grantham College	17	— Tele View Distributors	118
— Great Southern Security	125	159 The School of VCR Repair	27
— Greenleaf Electronics Inc.	108	136 Ucando Videos	112
155 Heathkit	23	141 US Cable (Zentek)	117
— I.C. Engineering	126	133 Weka Publishing	121
— Information Unlimited	13	— World College	15
36 Interactive Image Tech.	102, 103	— WPT Publications	117
— Intronics	126	134 Xandi Electronics	108
128 138 Island Logix Inc.	117		

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